2005 Hurricane Rita
Wildland Fire Risk Assessment

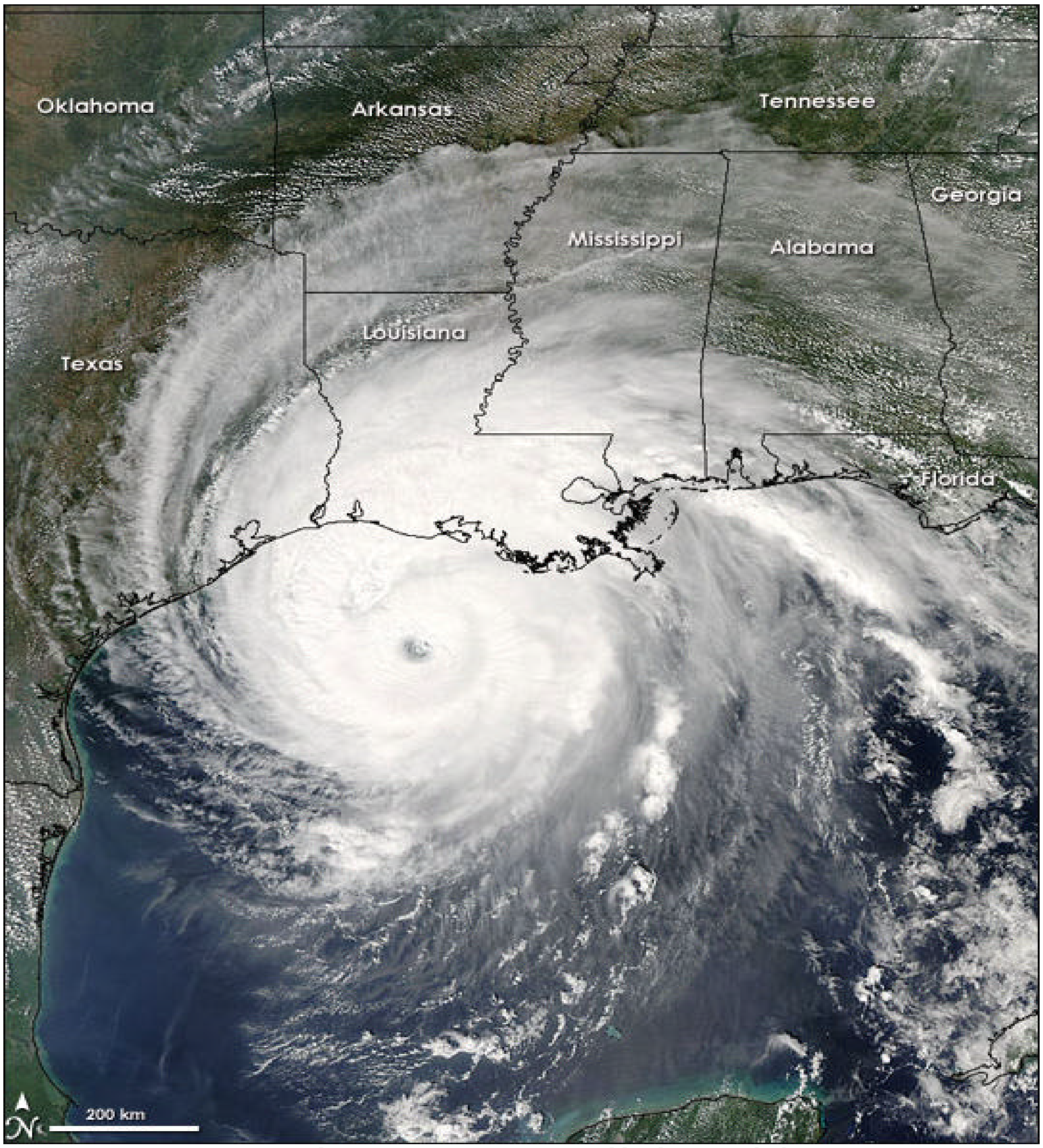

Photo provided by *MODIS Rapid Response Team, NASA Goddard Space Flight Center*

October 2, 2005

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Executive Summary

The central Gulf Coast has been impacted by two tropical storms (TS Arlene and Cindy) and three hurricanes (Hurricanes Dennis, Katrina, and Rita) during 2005. This report will focus on Hurricane Rita. The intent of this assessment is to evaluate increased wildland fire risk to the hurricane damaged areas. Hurricanes significantly impact forested lands at several scales and often set the stage for more intense fires. Descriptions of the hurricanes are included. After the 2004 Hurricane assessment it was estimated about 55 million acres were affected following the four hurricanes. Thirty two million acres fell into the damaged areas of Hurricane Rita.

Determination of post hurricane fuel conditions was done on a very general scale due to the time constraints. Maps displaying the wind velocity, rainfall patterns, and tornado activity were developed and used to generate maps of damage areas. Four damage level categories were determined (scattered light, light, moderate, and severe). This was validated based on visual observations and sample plots.

Lands falling in the damaged areas of Hurricane Rita is 31,600,000 acres, non-forested land are included in this figure. Those lands falling in the severe, moderate, and light damage areas will need additional preparedness, fire prevention and fuel reduction work to mitigate the damage caused by the hurricane. Ninety percent of the damage is located on state or private land, with the vast majority occurring on private land.

This additional workload is well beyond the normal fire budget of the state and federal agencies.

Local fire managers were contacted to verify damage and general assumptions used in this assessment, plus provide tactical proposals for mitigating fuel build up situations. The strategy includes prevention, preparedness (initial attack), and support to local fire districts and fuels treatments.

Short term forecast call for below normal rainfall amounts over the next 14 days. Experience from Hurricane Katrina shows fire activity can be expected to begin after just 7 days after the storm. Significant fire behavior will begin 14 days after the storm with no additional rainfall. No rainfall is in the forecast for the majority of the damaged area for the next 14 days.

Scenario Description for the Hurricane impact area, October 2005 – March 2005	**Probability**
Most likely Case Dry pattern continues in the short term, normal pattern develop in the long term Above Normal fire activity	60%
Best Case Wet pattern begins – Minimal fire activity	25%
Worst Case Normal weather pattern does not set up Above normal fire activity occurring until late March	15%

Recommendations

General recommendations are made for prevention, preparedness resource needs above normal staffing, and fuels treatment. Immediate and long term fire prevention activities should take place. Increases in the number and capabilities of initial attack resources are required. Also, extensive fuel reduction work will be needed. This will require both mechanical and prescribed burning activities, requiring collaboration with local, state and federal agencies.

Due to extraordinary costs and number of acres damaged, additional assessments will be needed. These can be done at the local level based on actually mapping the damaged area (which was not available at the time of this analysis) and tiered to state level assessments. The analysis at the state level will be needed in order to prioritize the work to be done and allocate funding.

Introduction

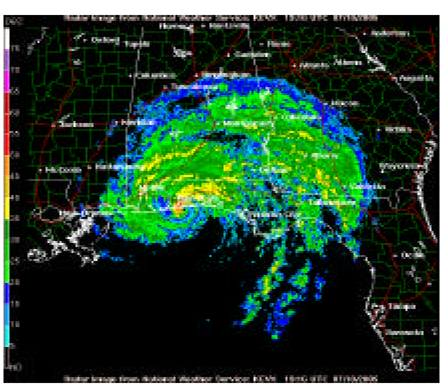
The demand for long-range fire assessments has been increasing during the last decade and increased needs for better information to support fire management decision-making will continue to grow (Mutch 1998). Long-range assessments ranging in magnitude have been periodically completed since 1987 for various parts of the United States (Zimmerman et al. 2000). Though the specific objectives vary on each project, these assessments generally look at short and long term wildland fire issues. Assessments are generally large in scale compared to a specific single wildfire event. A Hurricane Assessment was also completed in 2004 to evaluate the impacts of the four major hurricanes which hit Florida. The Hurricane Katrina Wildland Fire Risk Assessment was completed on September 5, 2005.

Fire activity began shortly after Hurricane Katrina. In many of the drought stricken areas of Texas and Louisiana, Katrina made little impact. Hurricane Rita did provide some relief to most of Louisiana and extreme parts of east Texas.

Unit	Human caused fires	Acres burned from human caused fires	Lightning caused fires	Acres burned from lightning caused fires
LA federal	15	8,275	0	0
LA state	161	3,009	0	0
MS state/federal	68	338	0	0
TX federal	19	597	2	3600
TX state	210	2,883	1	350
Totals	**473**	**15102**	**3**	**3950**

Significant Events

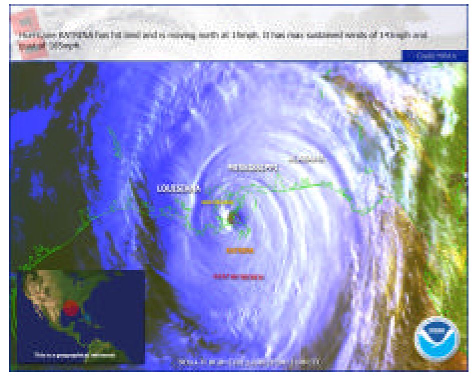
Hurricane Dennis



Dennis developed as a tropical storm on July 5th in the eastern Caribbean Sea. Dennis made landfall on the extreme western tip of the Florida Panhandle Sunday, July 10, as a strong Category 3 Hurricane.

Reported wind speeds were approximately 120 mph at the time of landfall and led to over 400,000 power outages along the coast and inland in Mississippi, Alabama and Georgia. Heavy rainfall also resulted from the storm leading to localized flooding in parts of the Southeast.

Hurricane Katrina

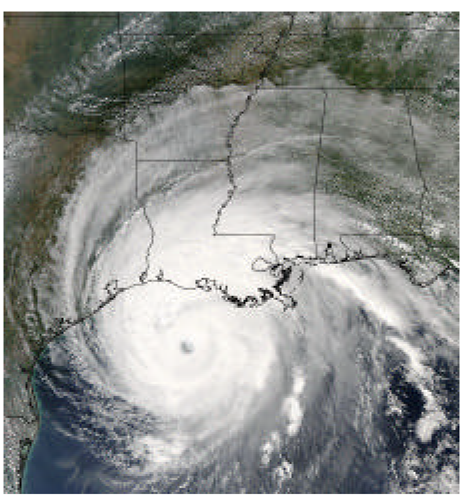


Katrina made first landfall on August 25th, between Hallandale Beach and North Miami Beach with 80 mph winds. Katrina then moved West across the southern tip of Florida, into the Gulf of Mexico and began to strengthen. Katrina made a second landfall on August 29 near Grand Isle, Louisiana with winds speeds of 144 mph. She then clipped the southeastern toe of Louisiana, and made a third landfall near Bay Saint Louis, Mississippi.

Katrina caused massive damage along her path. At least 80% of New Orleans was under flood water on August 31st, largely as a result of levee failures from Lake Pontchartrain. The combination of strong winds, heavy rainfall and storm surge led to breaks in the levee after the storm passed, leaving some parts of New Orleans under 20 feet of water. A storm surge of 20 to 30 feet left large portions of Biloxi and Gulfport, Mississippi underwater. As the storm moved inland and weakened to a tropical storm, rainfall amounts exceeded 2-4 inches across a large area from the Gulf coast to the Ohio Valley. Katrina was one of the strongest storms to hit the U.S. coast during the last 100 years.

The oil industry was also disrupted and oil production was reduced by 1.4 million barrels a day, causing gas prices to soar to record highs. Over 1.7 million people lost power in the Gulf States alone. As of this date (9/30) over 1,000 lives were lost.

Hurricane Rita



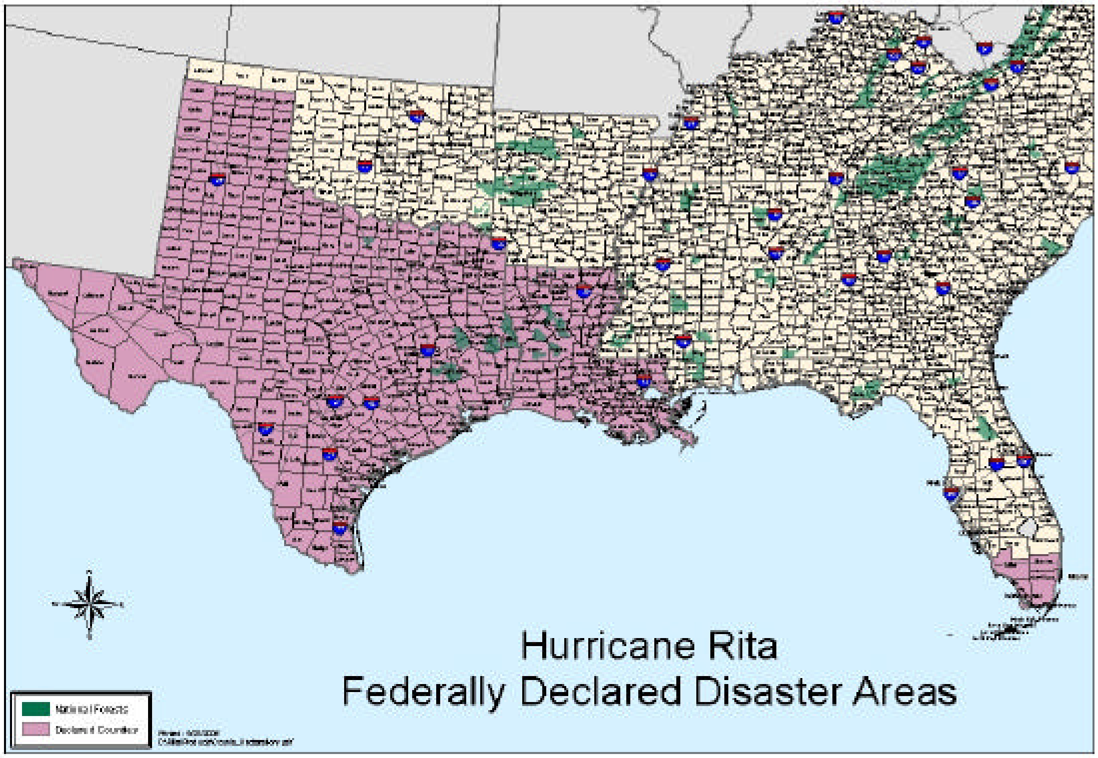
Hurricane Rita neared the Florida Keys on Tuesday, September 20, causing tropical storm force winds on Key West with gusts of up to 76 mph. Rita headed west into the Gulf of Mexico and by Wednesday afternoon Rita had become a category 5 hurricane, with winds reaching 175 mph. Prior to landfall, Rita weakened to a surface windspeed of 145 mph and continued to weaken gradually over the next 36 hours. On Friday, Rita headed west-northwest towards the Louisiana and Texas coasts. She made landfall in the early morning hours on Saturday, September 24, between Sabine Pass, TX and Cameron, LA, as a category 3 hurricane, with sustained winds of 120 mph. The storm surge reached 8 feet in New Orleans breaching the temporarily repaired levees damaged by Hurricane Katrina. Storm surge at landfall along the Texas/Louisiana border reached 15 feet, flooding coastal towns across the region. As Rita moved inland, she weakened to a tropical storm. Rainfall amounts exceeded 3 inches across a large area of Northeastern Texas, parts of Arkansas, Mississippi, Alabama, and Louisiana.

Over 1 million people lost power due to the storm; however parts of Louisiana still did not have power due to damages caused by Hurricane Katrina. Katrina and Rita made history, being the first two hurricanes, in recorded history, to reach category 5 strength in the Gulf of Mexico in a single season.

Recent Fire Activity

The month of September set a new historic record for the number of fires reported between the states of Texas and Louisiana. The Ouachita NF, Ozark – St.Francis NF, the National Forests and Grasslands in Texas, the National Forests in Mississippi and the Kisatchie NF were all in severity conditions prior to Hurricane Rita's arrival. The rainfall reduced the immediate fire threat in much of Louisiana and Arkansas. However, much of Texas, Mississippi and extreme western Arkansas received very little rainfall. Drought conditions are beginning to expand along the Appalachian mountain chain. Georgia had the driest September on record. High pressure is forecasted to move back into the region in October, bringing generally dry conditions over much of the area.

Declaration of Federal Disaster Areas



The objectives for the assessment by the team were to:

Generalize the effects of Hurricane Rita across the southern area.

Identify potential risk associated with the added buildup of fuels.

Identify mitigation measures needed to reduce the loss from wildland fire.

The team assigned included:

Clint Cross - USDA Forest Service, Atlanta, GA,
Tracey Adkins - USDA Forest Service, Atlanta, GA
Drew Leiendecker - USDA Forest Service, Santa Fe, NM
Kim Ernstrom - DOI National Park Service, Big Cypress NP
Roberta Bartlette – USDA Forest Service, Fire Science Laboratory, Missoula MT

The intent of this paper is to provide:

- A brief review of current conditions associated with the impact of Hurricane Rita on the southern portion of the United States as they relate to fire risk.
- An estimate of the potential damage to forested stands and how that relates to a change in fuels and fire behavior.
- A weather outlook for the remainder of the 2005 and beginning of the fire season.
- Suggestions for follow-up actions.

Current Situation

Tropical Storm Arlene

A tropical depression developed on June 8th off the coast of Honduras and became Tropical Storm Arlene, the first named storm of the 2005 Atlantic season, on June 9th about 170 miles west-southwest of Grand Cayman. Arlene crossed the western tip of Cuba with winds around 50 mph. After entering the Gulf of Mexico, Arlene reached peak winds of around 70 mph (near hurricane strength) in the eastern Gulf of Mexico before weakening prior to landfall near Pensacola, Florida on Saturday, June 11th. Sustained winds at landfall were approximately 60 mph.

Arlene's damage was primarily associated with flooding. At Gulf Islands National Seashore, Arlene washed out about 60% of the Fort Pickens Road and undermined the shoulder of the Opal Beach Road. About 4000 customers lost power in Escambia County, Florida and a possible tornado was reported near Navarre in Santa Rosa County, Florida. Funnel clouds were reported near Montgomery, Alabama. Rainfall associated with Arlene was widespread from western Kentucky southward across middle and Western Tennessee, eastern Mississippi, and most of Alabama. A small area of 5 to 8 inches fell in Northeast Mississippi. Arlene also gave widespread rainfall to Georgia and Florida.

Tropical Storm Cindy

Tropical Storm Cindy formed during the morning of July 5th from a depression that had tracked across the Yucatan Peninsula and re-emerged over the central Gulf of Mexico during the previous 2 days. When named, she was bout 255 miles south-southwest of the mouth of the Mississippi River. Cindy continued to track north and then northeast through the day of July 5th to make landfall near Grand Isle, Louisiana with maximum sustained winds of near 70 mph. Heavy rainfall and inland flooding accompanied Cindy as it headed northeast across the eastern U.S., weakening to a tropical depression.

Cindy was responsible for street flooding in southern portions of Mississippi and Alabama upon landfall. Some structural damage was also reported on Grand Isle, Louisiana. 24-hour rainfall totals of 4 to 8 inches were recorded along the Gulf Coast.

Hurricane Dennis

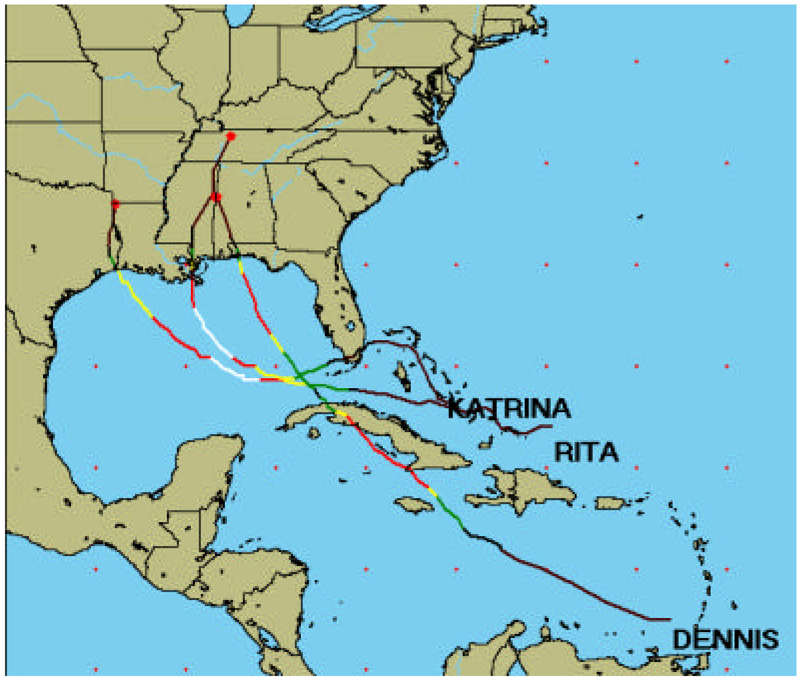
Hurricane Dennis also formed as a tropical storm on July 5th in the eastern Caribbean Sea, about 355 miles south of San Juan, Puerto Rico. Dennis continued to gain strength and was upgraded to hurricane status on the 6th; with maximum winds at 80 mph. Dennis tracked just to the north of Jamaica and grazed the south coast of Cuba before making a landfall at category 4 strength in south-central Cuba on July 8th. Hurricane Dennis weakened as it crossed Cuba, but regained strength in the eastern Gulf of Mexico as it moved north-northwest towards the northeastern shores of the Gulf.

Dennis made a second landfall near Pensacola, Florida on July 10th as a category 3 storm. Maximum wind speeds were approximately 120 mph at the time of landfall. Heavy rainfall also resulted from the storm leading to local flooding in parts of the Southeast.

Hurricane Katrina

Hurricane Katrina developed initially as the 12th tropical depression of the season in the southeastern Bahamas on August 23rd. This tropical depression strengthened into Tropical Storm Katrina on Wednesday, August 24. It then moved slowly along a northwesterly then westerly track through the Bahamas, increasing in strength during this time. A few hours before landfall in south Florida on August 25th, Katrina strengthened to become a category 1 hurricane.

Landfall occurred between Hallandale Beach and North Miami Beach, Florida, with wind speeds of approximately 80 mph. As the storm moved southwest across the tip of the Florida peninsula, Katrina's winds decreased slightly before regaining hurricane strength in the Gulf of Mexico. Katrina moved almost due west after entering the Gulf of Mexico. Continuing to strengthen and move northwards during the next 48 hours, Katrina reached maximum wind speeds on Sunday morning of 175 mph. Tropical storm force winds extended 205 miles from the eye of the hurricane. Katrina made landfall as a strong category four hurricane with maximum wind speeds of 144 mph on Monday August 29, 2005. She came ashore near Grand Isle, Louisiana. As she clipped the southeastern "toe" of Louisiana, she made a second landfall near Bay Saint Louis, Mississippi.



Katrina's track after landfall took her across eastern Mississippi and central Tennessee just east of Clarksville, Tennessee. She then moved toward the Covington, Kentucky and Cleveland, Ohio areas. She maintained at least tropical storm force winds well into southern Tennessee. She was downgraded to a tropical storm on Monday August 29, and then to a depression on Tuesday August 30. By the time she was categorized as a depression, she was located about 25 miles south of Clarksville, Tennessee.

Catastrophic damage occurred all along the Gulf Coast region. Even the Superdome in New Orleans, which was used to shelter 25,000 people, received damage to the roof and was flooded. Water rose so quickly in homes that people were trapped inside their attics before they could access the roof. Mandatory evacuation orders were given. As of this writing (Sep 30) over 1,000 deaths have been attributed to Katrina. The entire Grand Casino was lifted off and moved several blocks from its "anchored" location. The storm surge with this storm exceeded 20 feet, a disastrous amount of water for a city such as New Orleans that sits 25 feet below sea level. At least two levees in New Orleans broke and it is estimated that it will take at least a month to pump the water out of the city. Officials estimate that 80% of New Orleans is under water as a result of Katrina and is not expected to dry out until early October.

Hurricane Rita

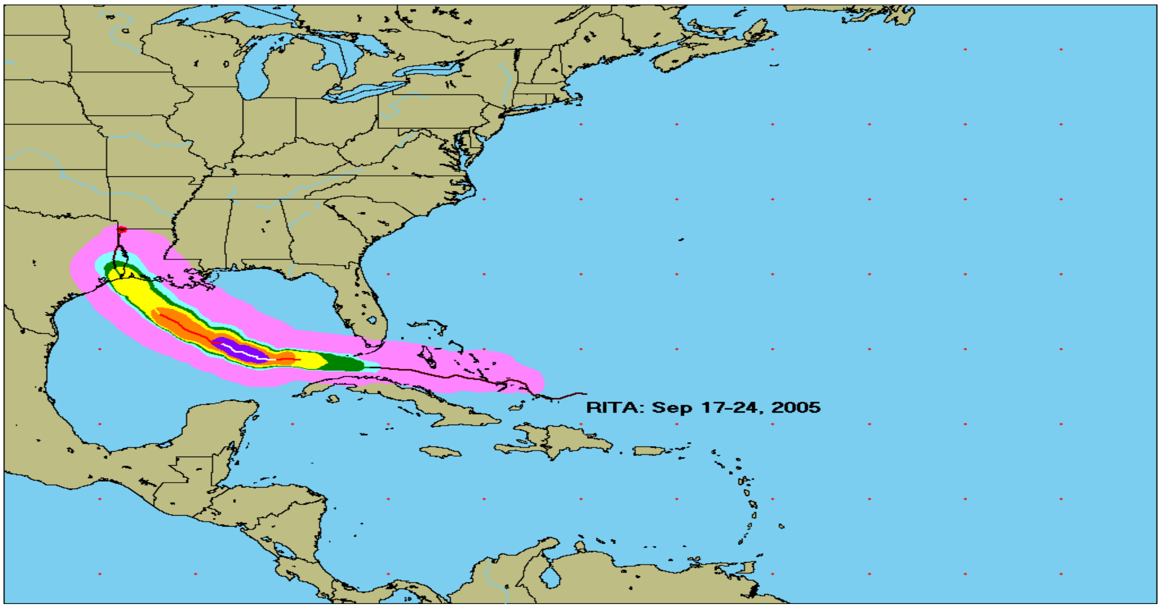
Tropical Storm Rita developed on September 18th and increased in intensity over the next 48 hours, becoming a category 1 hurricane. Hurricane Rita tracked just south of the Florida Keys on the 20th, causing sustained tropical storm force winds with gusts up to 76 mph on Key West.

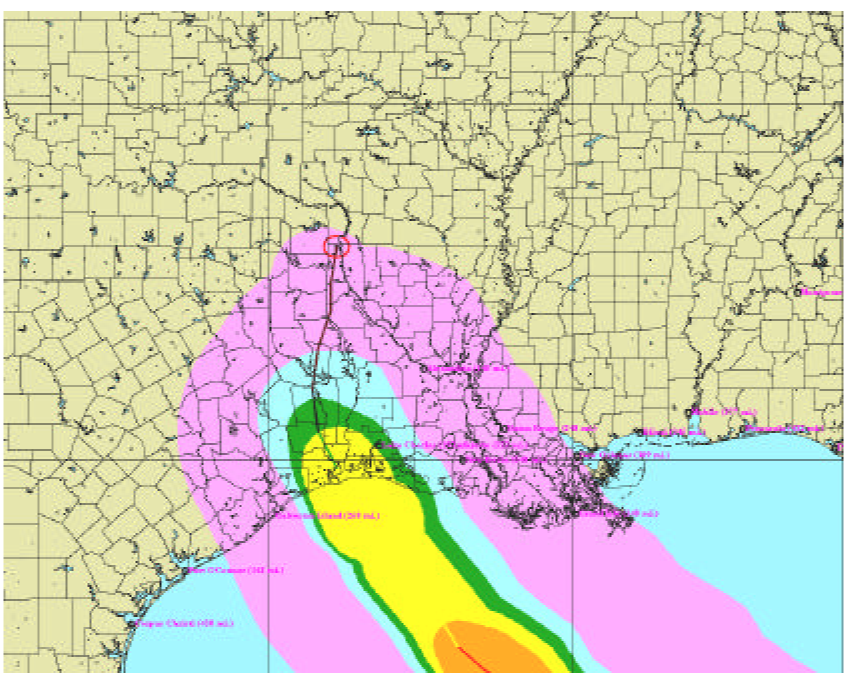
Hurricane Rita then headed west into the Gulf of Mexico and by Wednesday afternoon, she had reached category 5 strength, with winds of 165 mph and continued to intensify, reaching windspeeds of 175 mph. Rita weakened during the afternoon of the 22nd, and intensity dropped to a surface windspeed of 145 mph and continued to weaken gradually over the next 36 hours prior to landfall. Rita tracked west-northwest during the 23rd and made landfall at the Texas/Louisiana border early on the 24th, at category 3 strength with windspeeds of 120 mph. Hurricane force winds were sustained more than 150 miles inland and tropical storm force winds were felt as far north as the LA-TX-AR border.

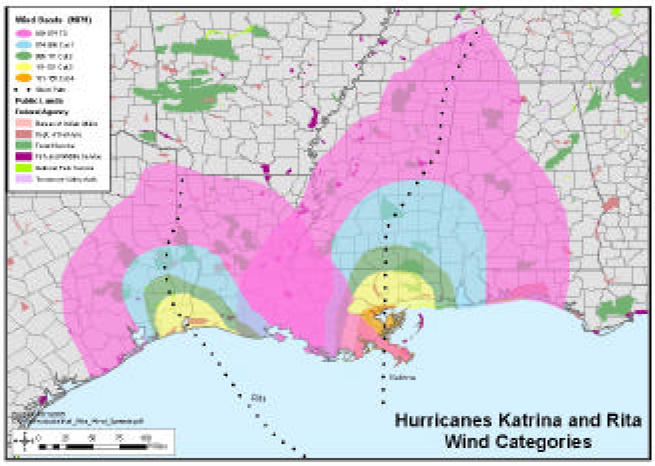
Hurricane Rita deposited up to 6" of rain on large portions of the Texas and Louisiana coastlines. As she moved inland and weakened to a tropical storm, rainfall amounts exceeded 3 inches across a large area of Northeastern Texas, parts of Arkansas, Mississippi, Alabama and Louisiana.

Wind Velocity Projections

The following charts illustrate the movement of Hurricane Rita as it made landfall across the southern tip of Florida, moved into the Gulf of Mexico, and made another landfall on the Texas/ Louisiana border. Wind speeds are depicted in the graph. The track of the eye of the hurricane and wind speeds is depicted on all charts.







These wind speed charts, along with rainfall patterns were used to evaluate the impact of the hurricane on fuel build up. This is a very rudimentary analyses used to identify areas that will require on site evaluation to determine actual fuel loadings and mitigation measures. The purpose here is to make an estimate of the number of acres impacted and to what degree the area has been damaged. The methodology for this analysis has been used on several assessments such as the 2004 Hurricane Assessment and the 2005 Hurricane Katrina Wildland Fire Risk Assessment.

Typical Fuels and Fire Behavior

The damage assessment area of Hurricane Rita straddles the Louisiana/Texas state line and stretches 300 miles along the gulf coast from Houston, TX to Houma, LA (see Hurricane Rita Damage Assessment map). The impacts were felt up to 160 miles inland encompassing most of the piney woods of eastern Texas and western Louisiana. Under normal circumstances fuels in the assessment area are comprised primarily of five FBPS fuel models – 2,3,4,7, and 9. A discussion of fuels and fire behavior can be broken down between the coastal marshes and prairies of the Gulf Coast and the forested piney woods of the western coastal plain.

Coastal Marshes

Freshwater marshes are non-forested, non-tidal wetlands dominated by grasses, sedges, and other freshwater emergent plants. Freshwater marshes are highly productive ecosystems and can sustain a wide variety of plant communities. In addition, the flat nature of most marshes helps to mitigate flood damage and filter excess nutrients from surface runoff. The Saline and brackish marshes that occur along the Gulf Coast of Texas and Louisiana are complex and highly productive ecosystems that contain a variety of plant and animal species. These plants and animals are specially adapted to fluctuations in salinity, water levels, and seasonal temperatures. Fire management in both fresh and salt water marshes consists of burning during the fall and winter every 1 to 5 years to prevent invasion of woody species and promote the growth of spartina and other marsh grasses (Nyman and Chabreck, 1995). It is preferable to burn during the fall and winter when wildlife is not nesting. Wildfires during periods of drought or before flooding can damage plant roots that are unable to recover if they are subsequently submerged for any length of time (Nyman and Chabreck, 1995). Hurricane and other tropical storm activity can play a role in maintaining plant species diversity within a marsh system, but can also contribute to coastal erosion and inland sedimentation. Saltwater intrusion from severe storms can "burn" freshwater vegetation causing marsh grasses and sedges to be killed (http://biology.usgs.gov/s+t/SNT/noframe/np104.htm).

Prairies

The coastal prairies of Texas and Louisiana stretch along the gulf coast for approximately 400 miles. They are characterized by tall grasses such as little bluestem, cane bluestem, tall dropseed, and a variety of midgrasses (handbook of Texas online). Whereas factors such as soil type and rainfall contribute to the formation of prairies, fire is the natural mechanism by which the prairie renews itself. Fire prevents woody plants from establishing, stimulates seed germination, replenishes nutrients, and allows light to reach young leaves. Historically, coastal prairie fires occurred in the summer as a result of lightning strikes. Fires, along with drought and competition from herbaceous plants, prevented the establishment of woody plants to maintain a grass-dominated ecosystem(http://www.tpwd.state.tx.us/landwater/land/habitats).
Fire management in this habitat type typically takes place in the winter and spring on a 2-3 three year rotation. Fire behavior is characterized by rapid rates of spread that topkills woody species and removes the cured grasses.

Western Coastal Plain (East Texas/Western Louisiana Piney Woods)

Vegetation of the western Coastal Plain is best characterized by two types of pine-dominated forests: 1) well-drained sandhill and pine forests and 2) pine savannah wetlands that are wet for part or most of the year.

Pine Sandhill and Pine Forests

Pine Sandhill and Pine Forests are found on well-drained sandy soils with a mixture of loblolly, longleaf and shortleaf pines. The Pine Sandhill forest consists primarily of a sparse herbaceous understory, patches of bare sand and a shrub component dominated by bluejack and post oaks. Pine Forests can have a dense understory of post oak, sumac, sassafras and wax myrtle with a herbaceous layer of forbs and grasses such as bluestem. These well-drained forests are characterized by a frequent, low to moderate intensity fire regime. Prescribed burning is typically conducted on a 3-5 year rotation to maintain the sites. The poorly developed soil profile keeps duff depths to a minimum and the lack of available large fuel results in an intense fire of short duration. Little or no mop-up is usually required. Burning conducted during dormancy will maintain a low density rough.

Pine Savannah Wetlands

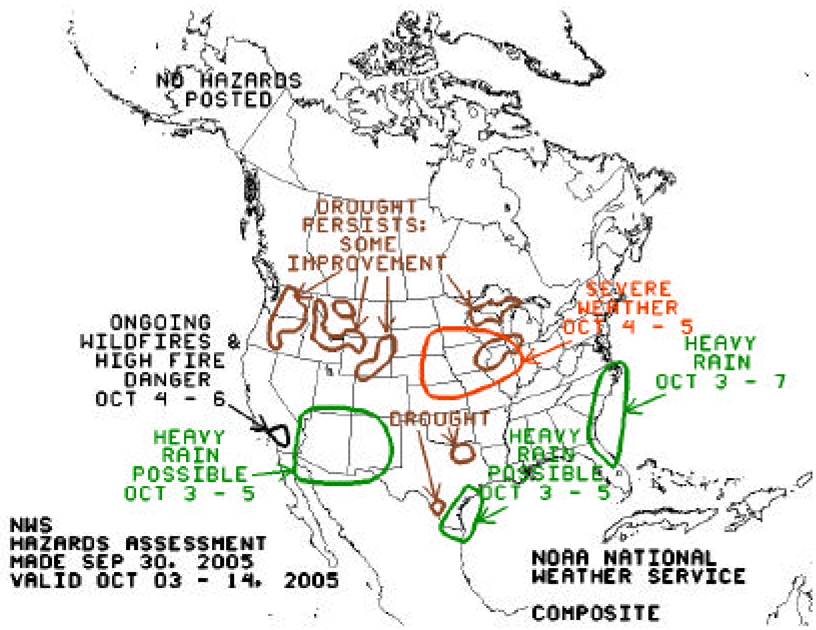
Wetter pinelands occur in areas of poor drainage. These Pine Savannah Wetlands contain scattered longleaf pine with some blackgum and sweetgum in the wettest areas. The mid-story of these forests is the most noteworthy aspect in relation to fire management as shrubs consist of highly volatile sweetbay, wax myrtle, titi and gallberry. This forest type typically burns only under extreme conditions, but receptivity to fire can be exacerbated by needle-drape from the pine overstory. When fires do occur, smoldering ground fire can consume massive amounts of fuel and cause long-term problems with smoke production. Once the soil layer is exposed root structures can weaken, toppling or killing overstory trees.

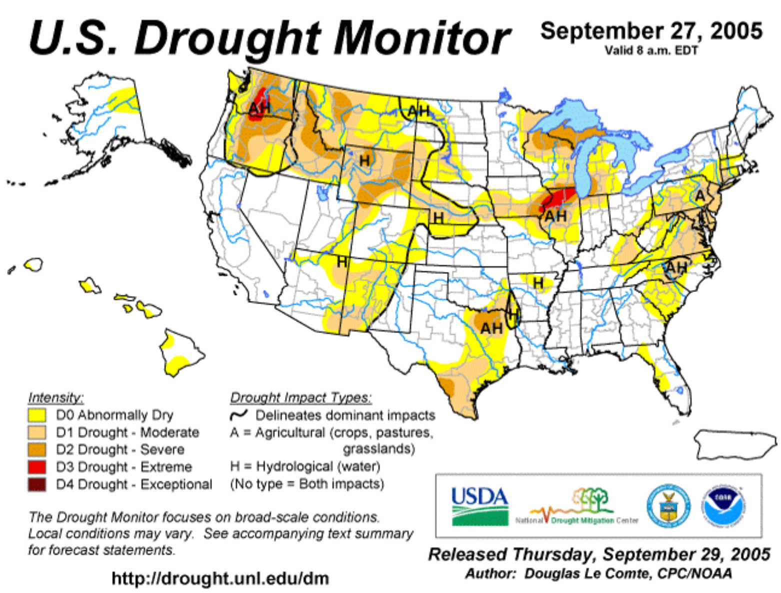
Short and Long Range Weather Forecast

Current Conditions

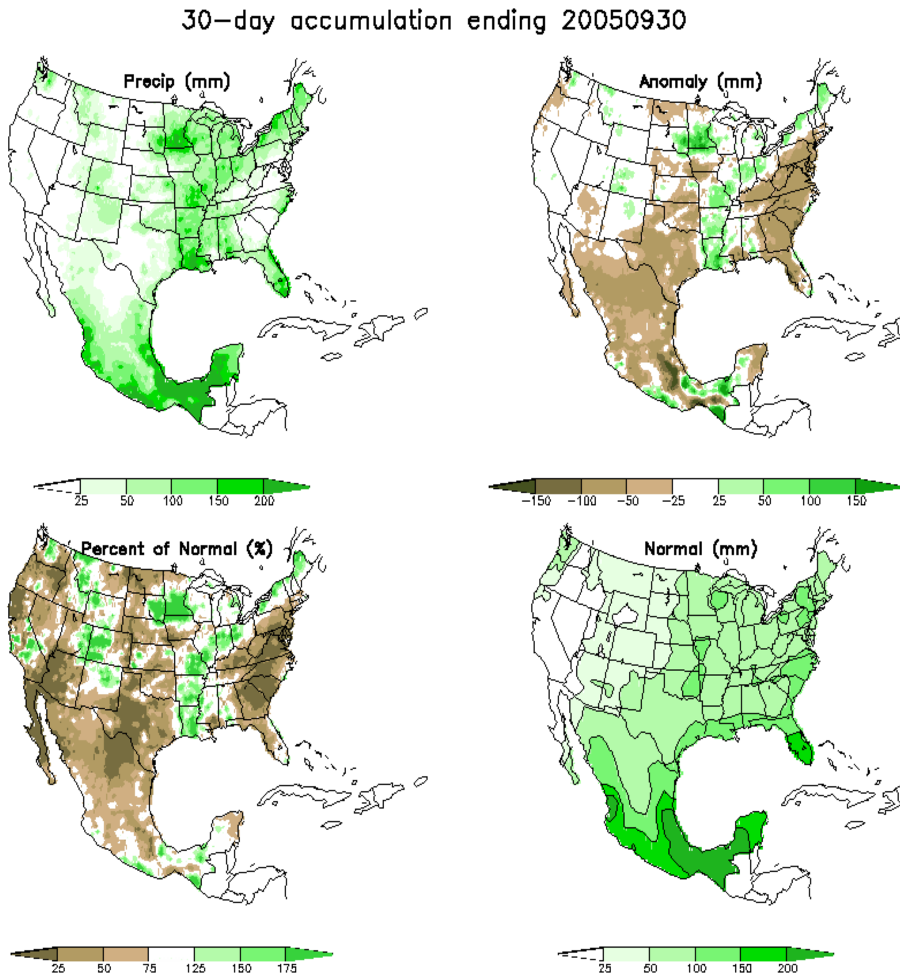
The area impacted by the hurricane has generally been in drought conditions over the last several months. The area hardest hit by drought in the affected area is the central, east Texas area and central portions of western Louisiana. Fortunately, this area received the most rain. However, the heaviest rain was focused in a small area and drought conditions still exist in many areas of Texas.

The current NWS hazards assessment map depicts the area of drought in North Texas with some heavy rains possible in deep, south Texas and the coastal areas of the Carolinas and Florida. This rain fall is associated with tropical development and is not expected to impact the affected areas of Hurricane Rita or Katrina. This rain will not affect the areas of the region currently in drought or drought development.



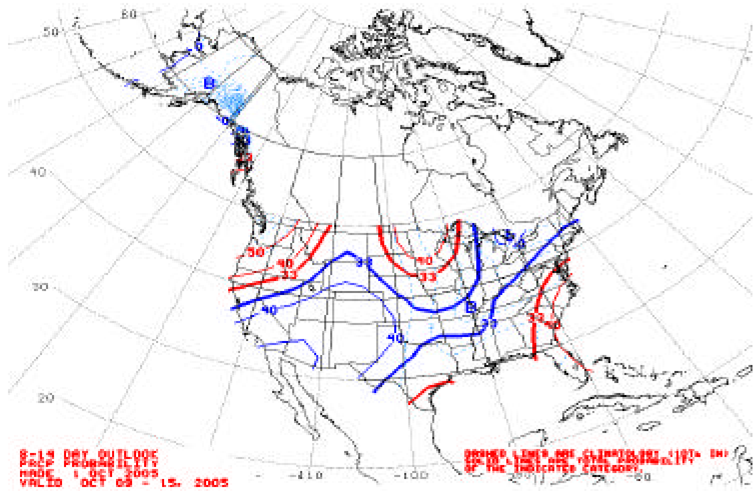


The US drought monitor illustrates the current areas of drought in Texas and the extreme SW corner of Oklahoma. Also notice the drought development in the Appalachian Mountain chain.

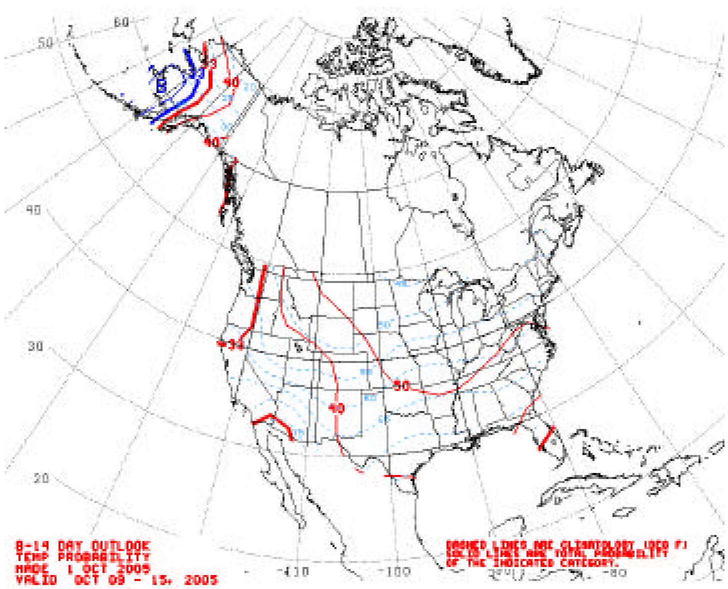


The 30 day accumulation chart does take into account the rain fall associated with Rita. One will notice, even with the large rainfall amounts associated with the storm, Texas is still very dry. Focus on the lower, left quadrant of the chart which depicts the percent of normal precipitation. This indicates the significant area of Texas which still has dry conditions. All the rain associated with Rita in Texas fell east of I-45. The hardest hit area of drought in the state was unaffected by the hurricane.

Short term forecast

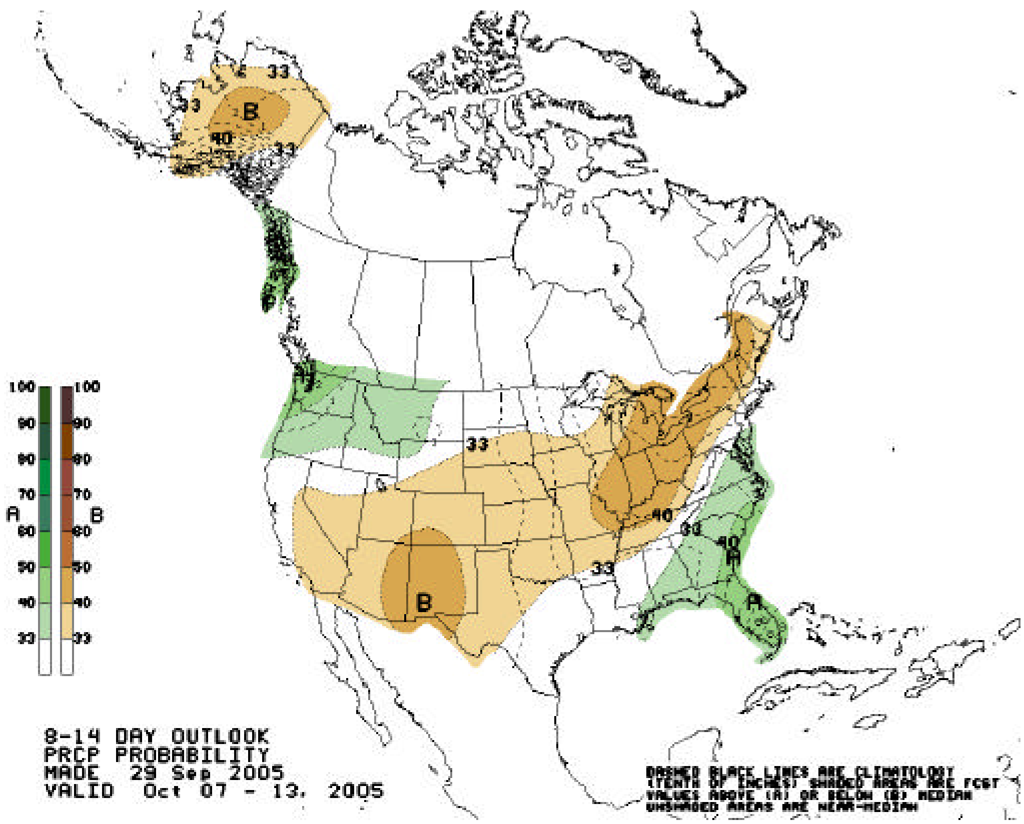


The high pressure that has remained in place over much of the region is expected to remain. Cold fronts of increasing intensity are expected over the next several weeks, however, these frontal passages will likely only help to provide light amounts of rainfall. The current and forecasted weather pattern is expected to provide normal to below normal precipitation to much of the region. To the right, is a chart showing a significant chance of below average precipitation from Texas, east to the Appalachians for the 8 to 14 day range. A significant chance of above average precipitation is predicted for the coastal areas of the Carolinas, south to Florida.



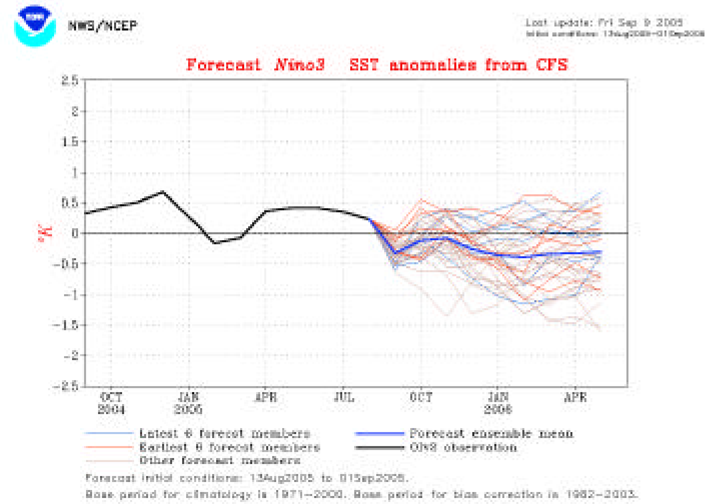
The chart to the left illustrates the 8 to 14 day outlook for temperatures. Notice there is a significant change for above average temperatures for the entire geographic area.

The graph below is simply a color-filled 8 to 14 day precipitation map as shown previously. As high pressure is expected to build back in behind the next series of frontal passages, higher than normal temperatures will likely follow. Notice southern Mississippi may see some relief in the short term. This will be associated with increased moisture from the Gulf. However, October is historically the driest month of the year. Data from the current models are not strong enough to support discounting the normal climatology for this area.

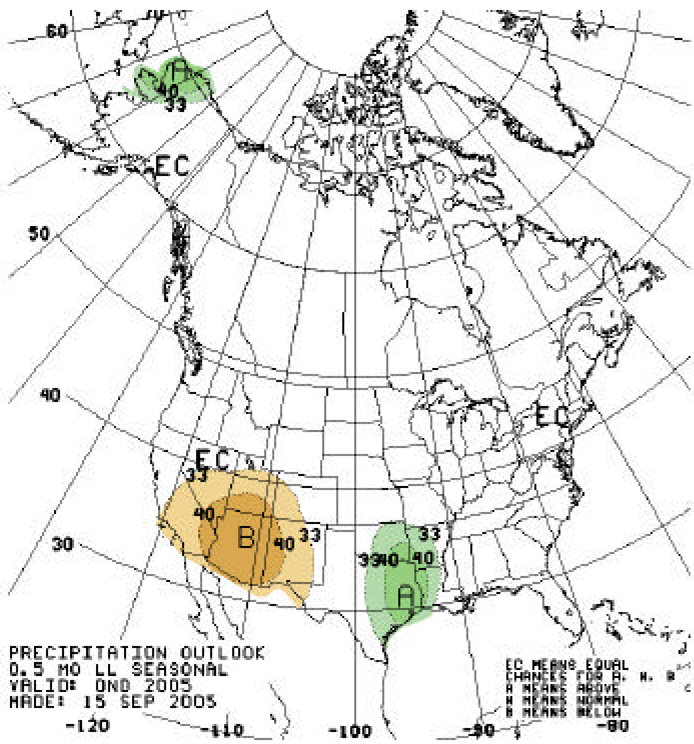


It is also important to note the average "days since rain" for this area is about 20 days. Based on the mid term forecast, it is likely the area that will at least reach this mark by the middle of October. Historically, east Texas does not have much of a Fall fire season. This is mainly due to a combination of multiple factors such as, decrease daylight and increased moisture associated with frontal passages.

Long Range Forecast



The long range outlook, provided by the Climate Prediction Center's website, shows small, short term fluctuations to continue to dominate the SST anomaly field. The latest ENSO advisory indicates there is considerable uncertainty. However, current conditions and recent observed trends support a continuation of ENSO-neutral conditions for the next three to six months. This would lean the long term forecast to follow normal climate trends.



The 90 day outlook which covers October through December shows generally normal climatology for much of the region. The area showing above normal precipitation for east Texas, Louisiana, Arkansas, and Oklahoma is trying to depict the affects of Hurricane Rita.

There is considerable uncertainty in the extended forecast. The most recent model forecasts range from a weak La Nina to a weak El Nino. Model runs over the next 14 days indicate very little precipitation in the hurricane impact area. It appears the best estimate at this point is a persistence forecast. It is important to note the area generally is impacted by frontal passages which will bring rain. However, this is not indicated in the recent models to a strong degree. So, it historically appears a change in the weather should be in place soon, which would bring additional rain to the area. However, this is not indicated in the model outputs.

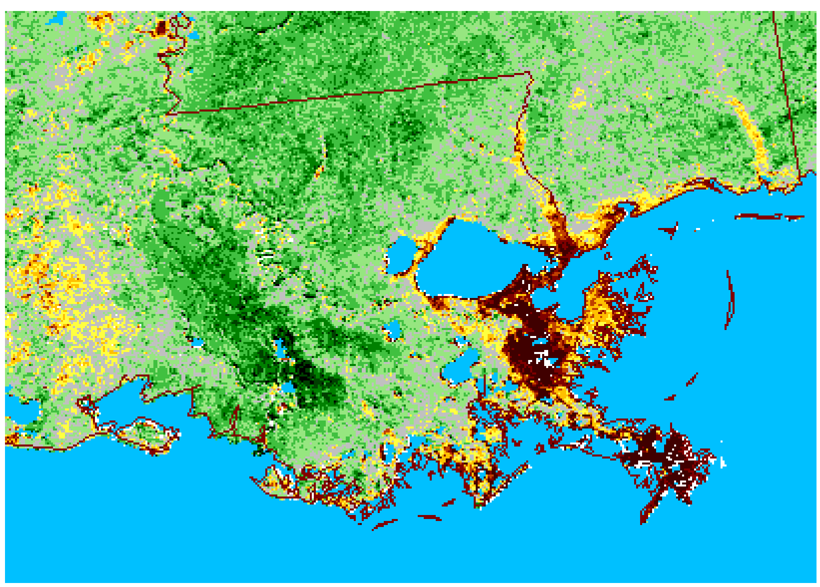
Fire Danger (Greenness Imagery and Fire FamilyPlus)

Greenness Imagery

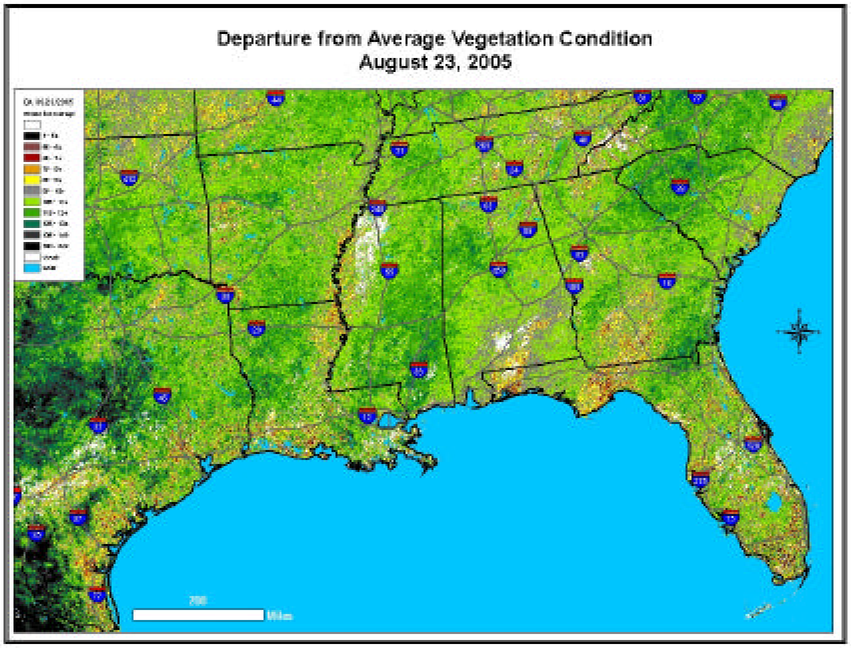
Satellite observations have been used to assess vegetation greenness as it relates to fire danger (Burgan and Hartford, 1993) and fire business (Burgan and others 1996). This information is obtained from NOAA polar-orbiting weather satellites that use the Advanced Very High Resolution Radiometer (AVHRR) to analyze red and near-infrared reflected light. The weekly updated Normalized Difference Vegetation Index (NDVI) images, typically displayed as maps, are useful to assess the current vegetation condition and to monitor change over time. Image history dating to 1989 allows comparison of current condition to average conditions or to conditions during episodes of significant departure from normal long or short term weather conditions. Departure from Average (DA) images compares the weekly NDVI data to average conditions for the same time of year. Relative Greenness (RG) images display the current greenness as compared to the historical range of greenness.

These images have been used in seasonal assessments to help express the potential contribution of live fuels to fire danger (Zimmerman and others 2000). This imagery also provides a means to visually dsplay the curing or drying process of fuels damaged by severe wind events as shown following the 1999 Independence Day windstorm in northern Minnesota (Leuschen and others 2000).

NDVI imagery and the derived image types were examined following Hurricanes Katrina and Rita. Change in vegetation condition as shown in images following hurricane Katrina can be used to estimate the severity of damage and extent of change that may be expected following Hurricane Rita. Satellite images detected little change in vegetation in South Florida following Hurricane Katrina, perhaps due to the resilient nature of the plants and their rapid growth response following hurricanes. Hurricane damage to vegetation north of the Gulf Coast was apparent in satellite images.

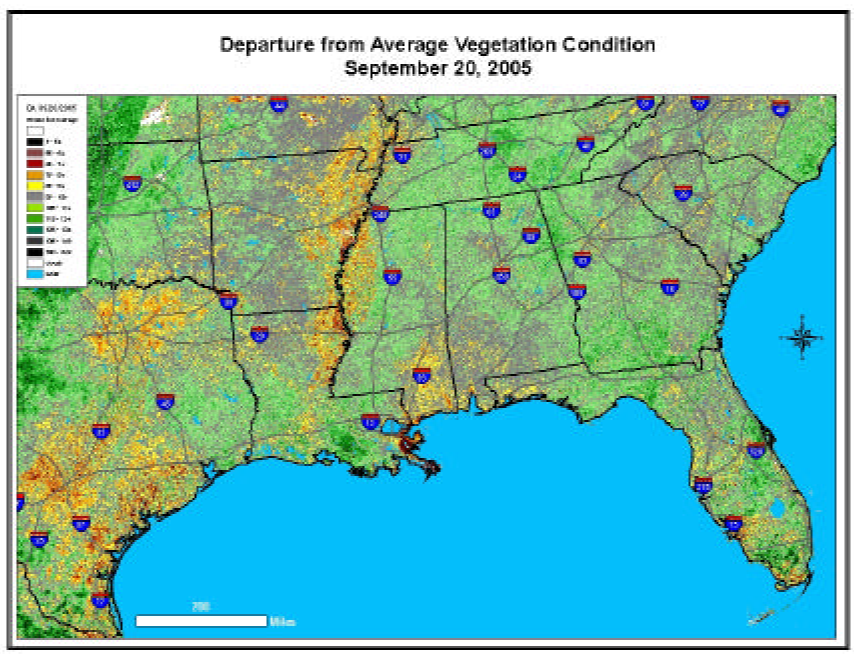


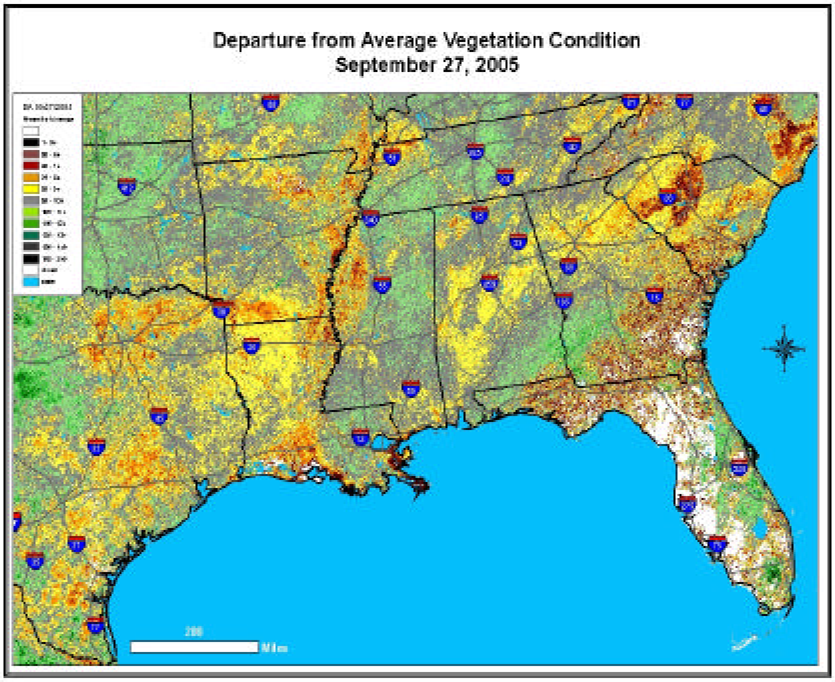
Salt and wind damage along coastal Louisiana due to hurricane Katrina was immediately visible in greenness images the first week following the hurricane's landfall. Dark brown areas indicate vegetation at less than 50% of normal greenness. White areas are essentially barren. Yellow areas indicate more rapid than normal curing. Storm damage was beginning to show in vegetation along Hurricane Katrina's inland path. Green areas indicate vegetation that remains greener than average for the time of year.



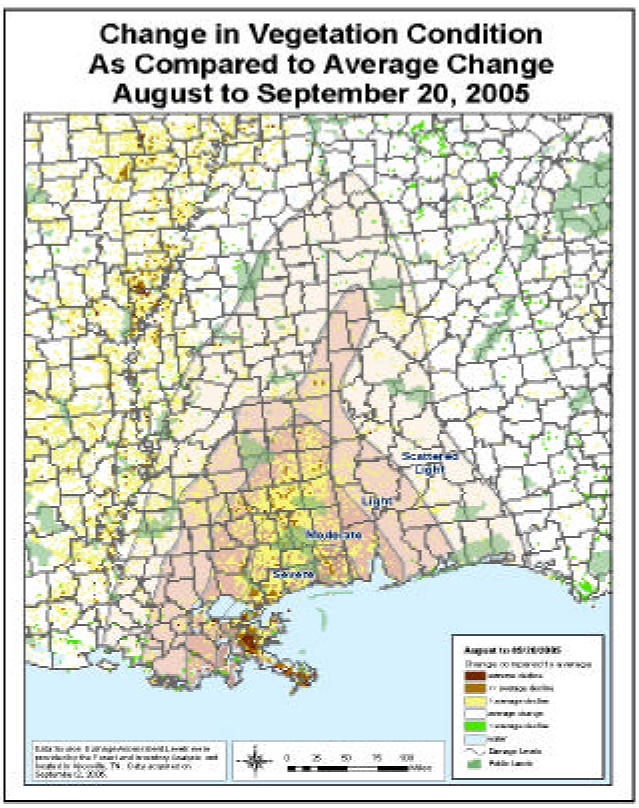
The departure from average map to the left illustrates the conditions prior to Hurricane Katrina making landfall. Notice generally normal to above normal conditions across much of the severely to moderately damaged areas.

The chart to the right shows the departure from average three weeks after Hurricane Katrina. As mentioned above, the yellow and dark brown areas indicate rapid curing of the vegetation. This was validated on the ground by red pine needles found on broken tree tops on the ground. The yellow area in Southern Mississippi and SW Alabama was in the severe to moderate damage area.





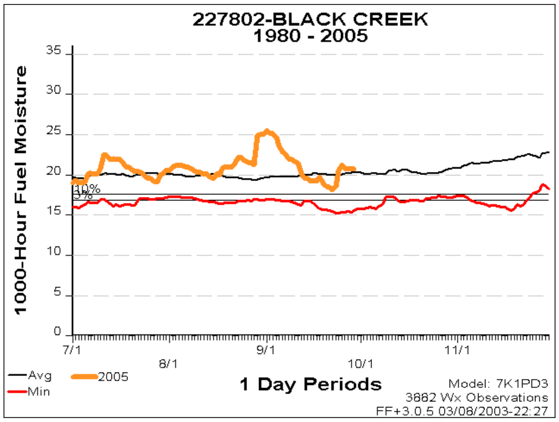
This chart depicts the departure from average one month after Hurricane Katrina. Notice in southern Mississippi the area that once was yellow is now grey. This is beginning to show more normal greenness values for this time of year. However, there are still many areas in southern Mississippi which are drier than normal. Much of the pine debris at this time has completely browned out and is fully available to burn. Also, notice the very dry conditions across the future impact area of Hurricane Rita.



The map to the left illustrates the change in vegetation conditions as compared to average change from August to September. The decline in vegetation conditions is evident in the severe and moderately damaged areas. Notice significant decline in greenness values along the exact path of the severe to moderately damage areas. It is reasonable to expect the same decline in greenness values over the track of Hurricane Rita. Generally, in the seven to ten day period after the storm, pine debris began to turn brown and was available to burn. In the ten to fourteen day time frame, this debris contributed readily to fire line intensity and provided a good source for spotting.

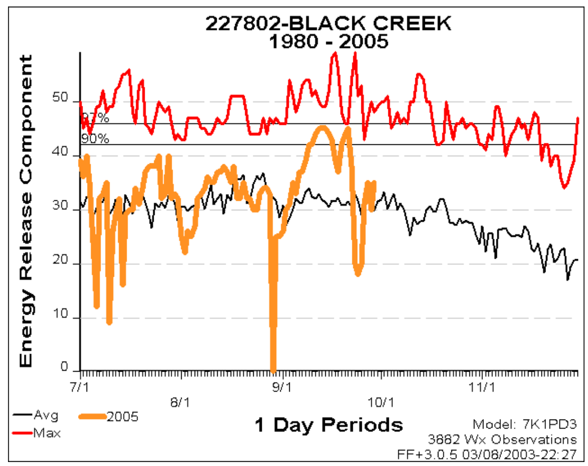
Fire Family Plus

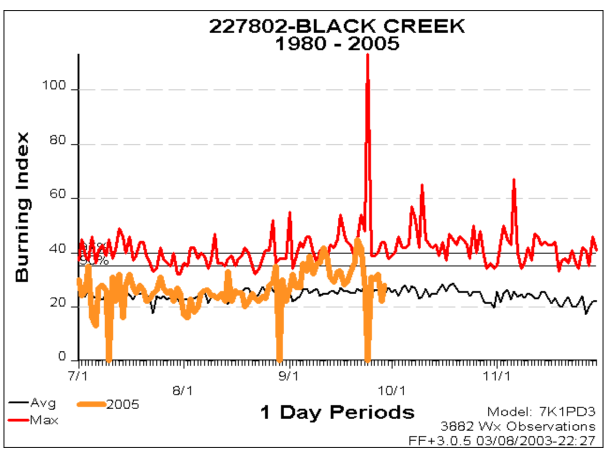
Fire FamilyPlus was used to evaluate the cumulative effects of Hurricane Katrina and Hurricane Rita on fire danger across the affected region. This was done by selecting RAWS (Remote Automated Weather Station) units that were within the major storm paths of both hurricanes. Four different RAWS sites were selected between east Texas and southern Mississippi to illustrate potential fire danger in the areas most affected.



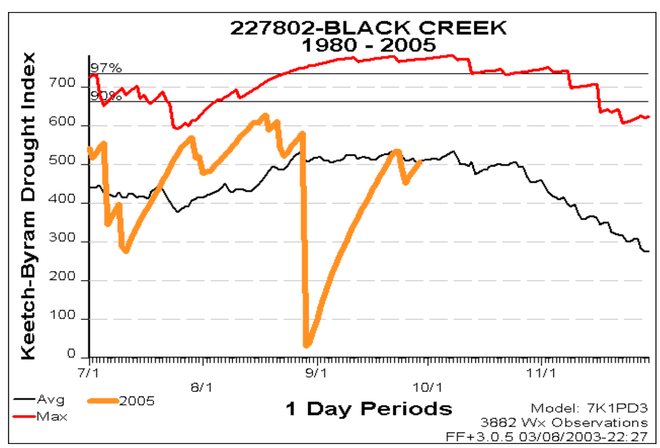
As can be seen in the graphs from the Black Creek (RAWS) unit in Southern Mississippi, fire danger in the area was immediately lowered with the passing of Hurricane Katrina. However, fire danger quickly increased following the three week drying trend following Katrina. To the left, the 1000hr fuel moisture has a drop from 25% after Katrina, to 18% following the three week drying trend. It is important to note that anything below this 18% is a local threshold for significant fire behavior.

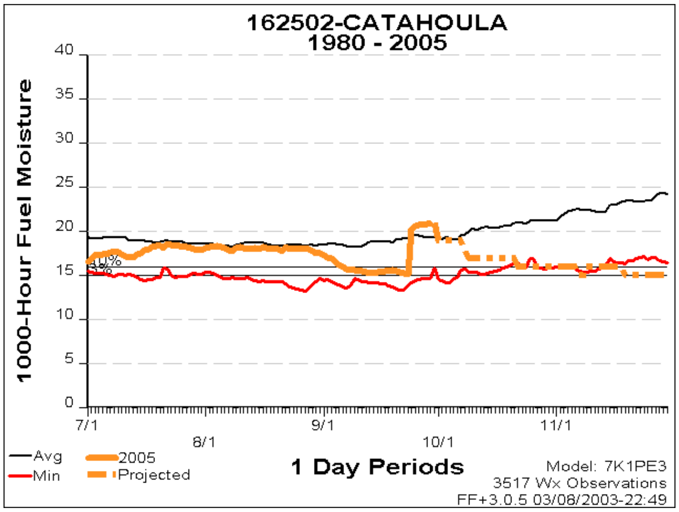
The graphs to the right and below represent the energy release component and burning index. Note the large decrease in both indices at the end of August (Hurricane Katrina) and the marked increase in the indices to near historic maximums in a short period of time.



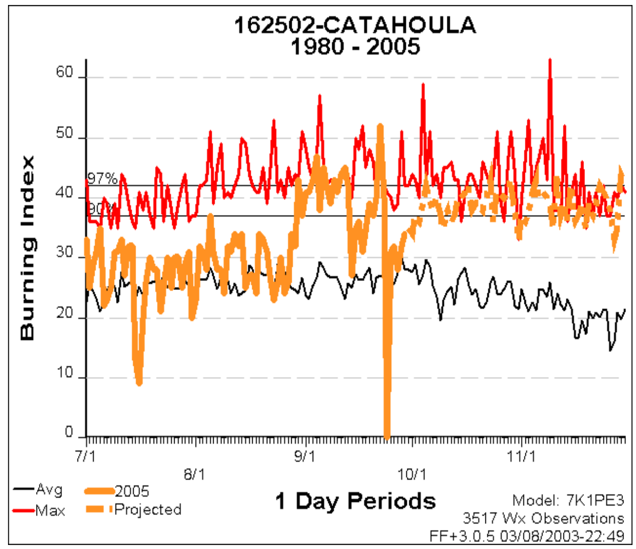


The KBDI illustrates the quick drop with Katrina and notice there is very little change in the KBDI following Hurricane Rita. There was very little rain associated with Rita in Southern Mississippi.

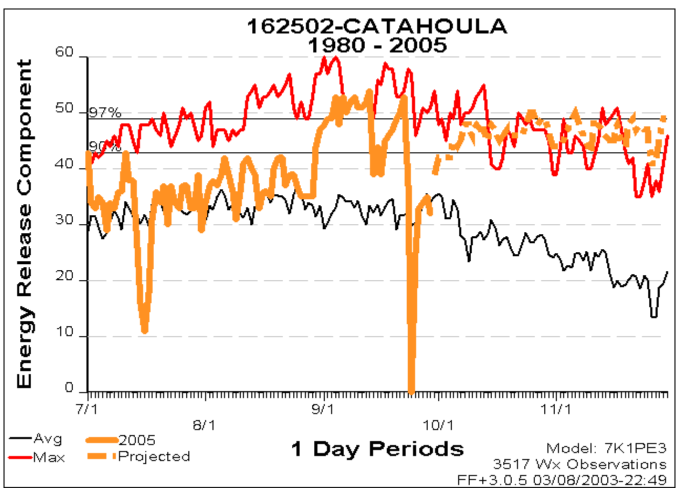




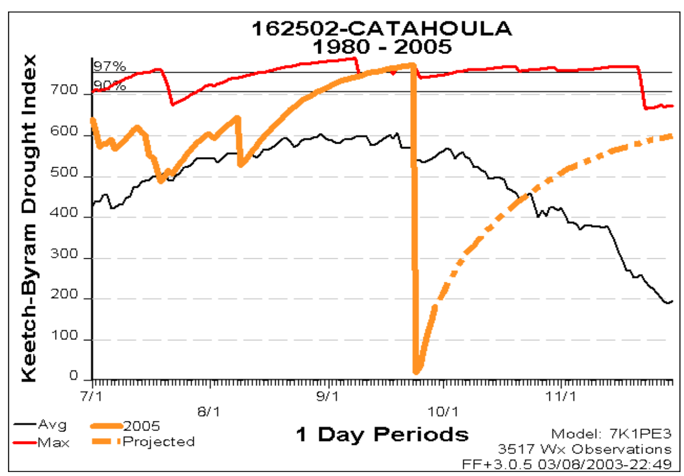
The following graphs depict the impact of Hurricane Rita. This was taken from a RAWS station on the Kisatchie NF. It is important to note the projected indices on the following graphs. The projections were completed by climatology based on current weather forecast. Note the graph to the left shows 1000hr fuel moistures reaching historic values in two weeks.

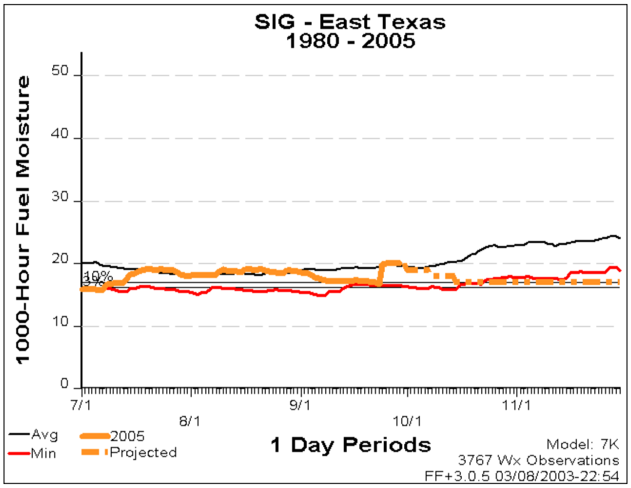


The burning index and energy release component are forecasted to also reach historic maximum values in the next two weeks.

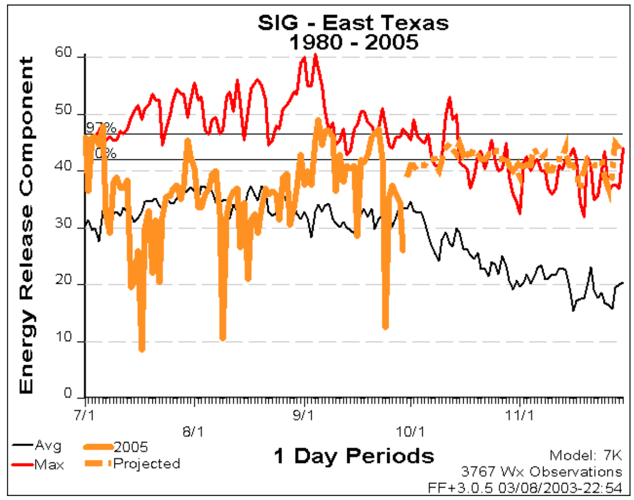


The KBDI graph to the right shows several more weeks until the KBDI reaches average values for this time of the year. This is a misleading indicator due to the rainfall event. Rainfall durations were short during the hurricane passage so most of the rainfall was not beneficial to the vegetation. The other factor to consider is much of the vegetation was physiologically dead.

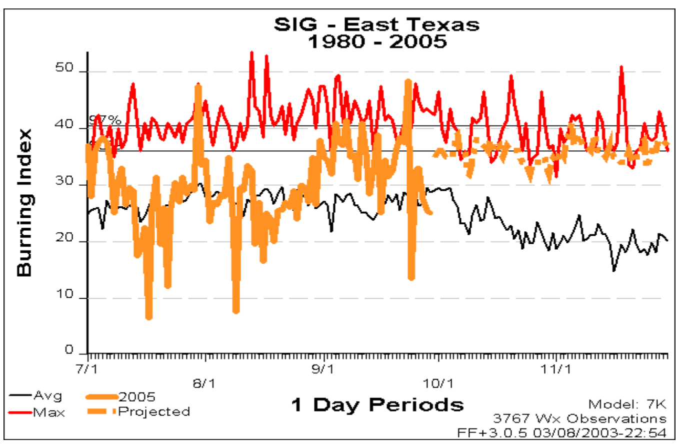




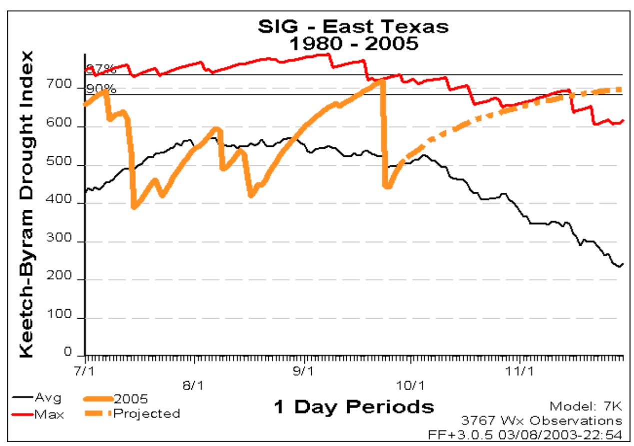
The east Texas special interest group (SIG) was created by grouping the Conroe and Lufkin RAWS. This represents the area in the light to moderate damage categories. Note the forecasted indices are also included on this graph using the same methodology as before.

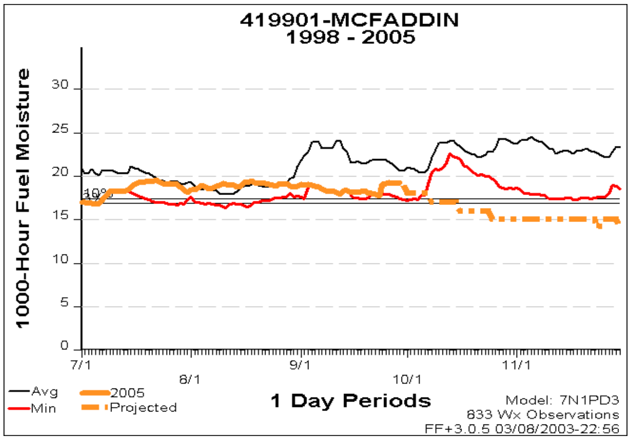


The burning index and energy release component for east Texas shows the same trend as Louisiana. Both indices are forecasted to reach maximum values in the near future.



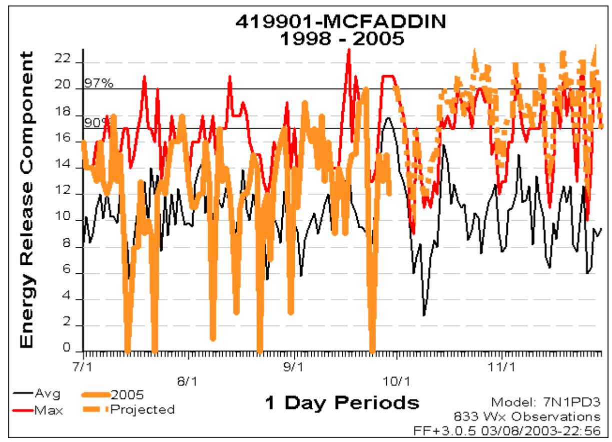
The impact of Hurricane Rita on the KBDI was generally moderate in Texas. Notice the KBDI was only returned to normal levels for this time of the year. It will most likely return to historic levels in a few weeks.

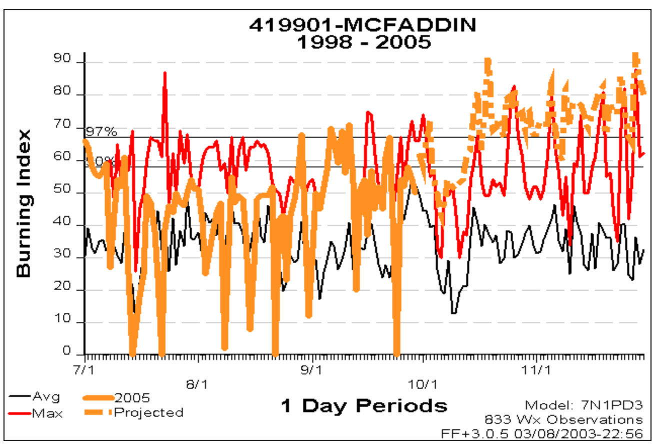




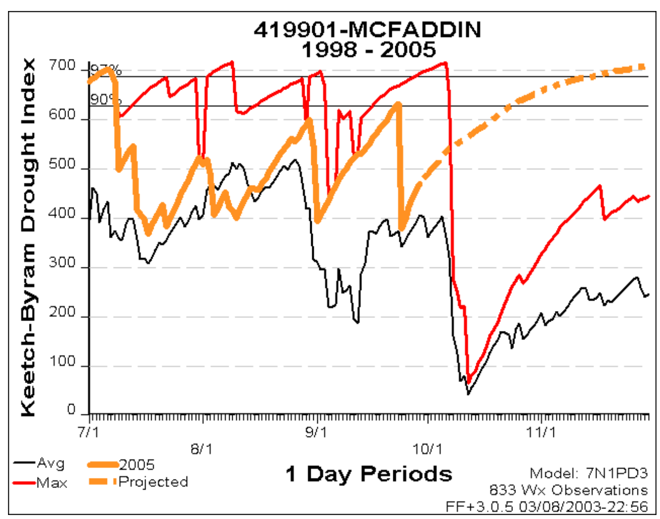
The following graphs represent the NFDRS indices taken from the MCFaddin NWR. This location was on the west side of the hurricane as it made landfall. Notice the little change in 1000hr fuel moisture values. The indices are also forecasted using the methodology mentioned above. 1000hr fuel moistures will begin breaking new records, if the forecast holds true.

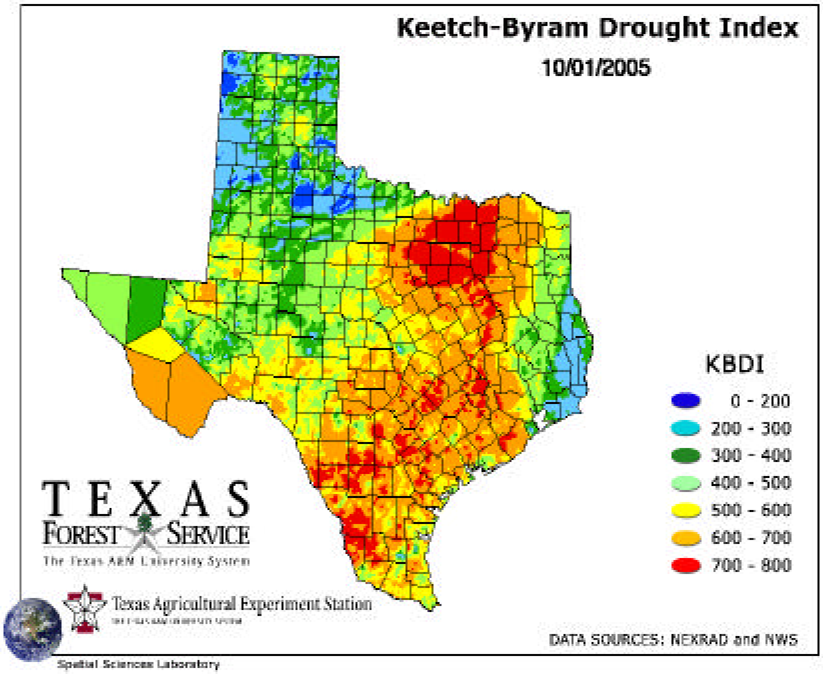
The burning index and energy release component show a sharp drop immediately following the hurricane and the forecast calls for both indices to reach historic maximum values in the immediate future.





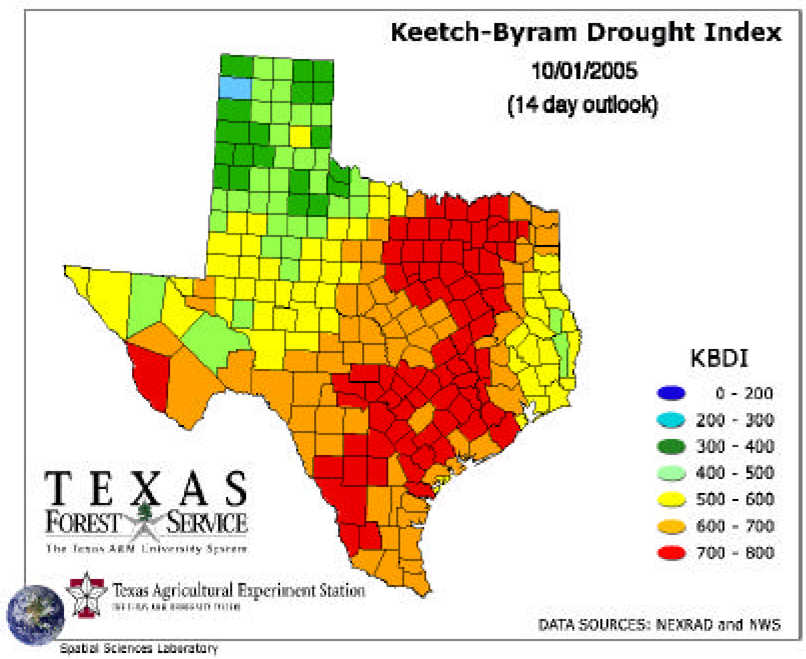
Hurricane Rita brought the KBDI back in line with average values for this time of the year. However, forecasted values are projected to reach maximum levels for this time of the year in the near future.





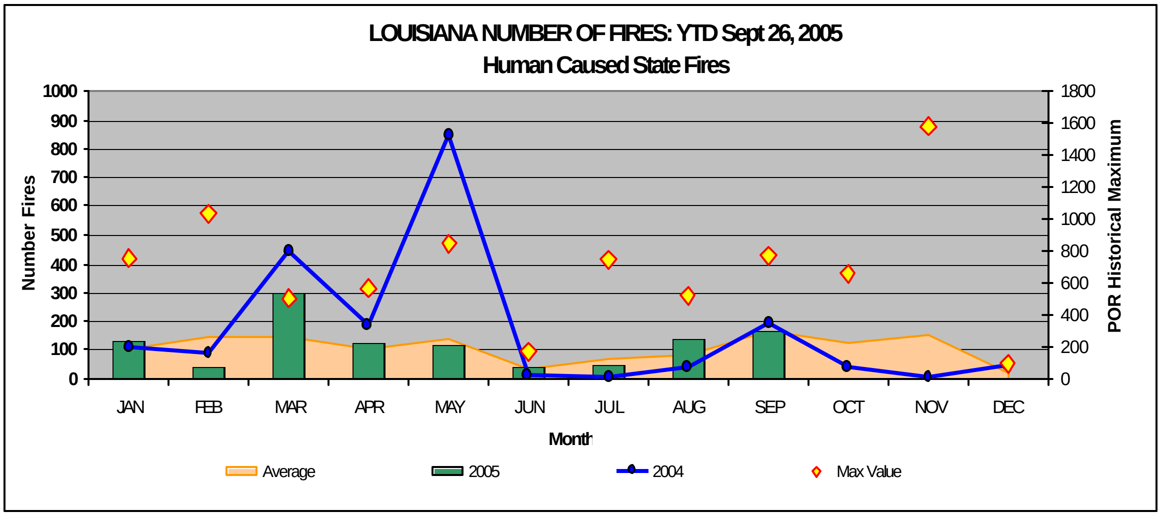
The Keetch-Byram Drought Index (KBDI) decreased significantly some extreme east Texas due to the rainfall from Hurricane Rita. However, the impact was relatively local in nature in relation to the overall drought areas in Texas.

The KBDI map to the right depicts the 14 day predicted KBDI starting from October 1. So, the KBDI predicted on this may shows the KBDI for October 15. Notice the rapid increase in KBDI to near critical levels in a short time frame.

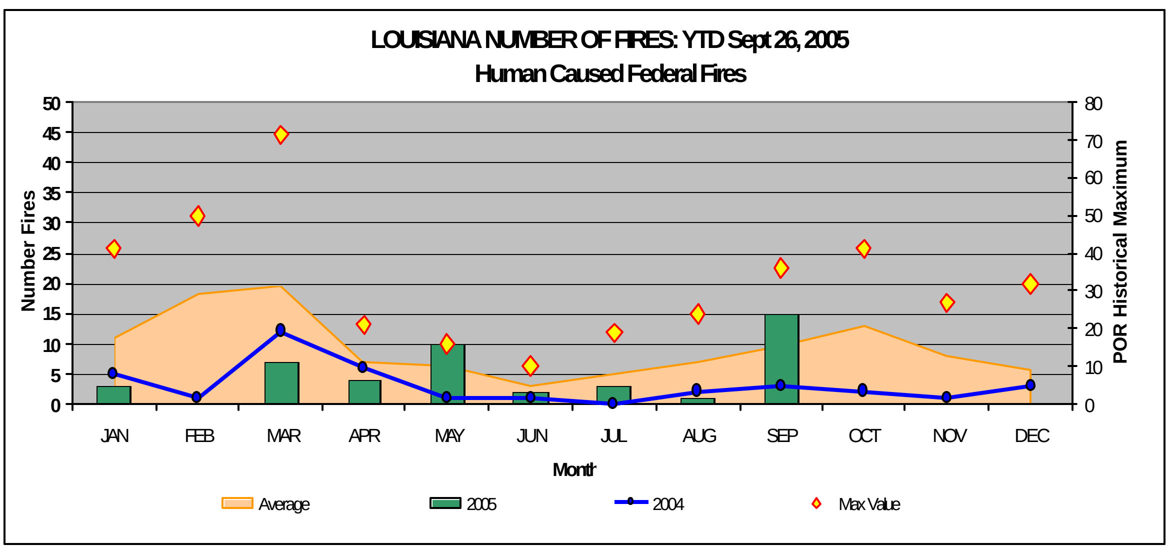


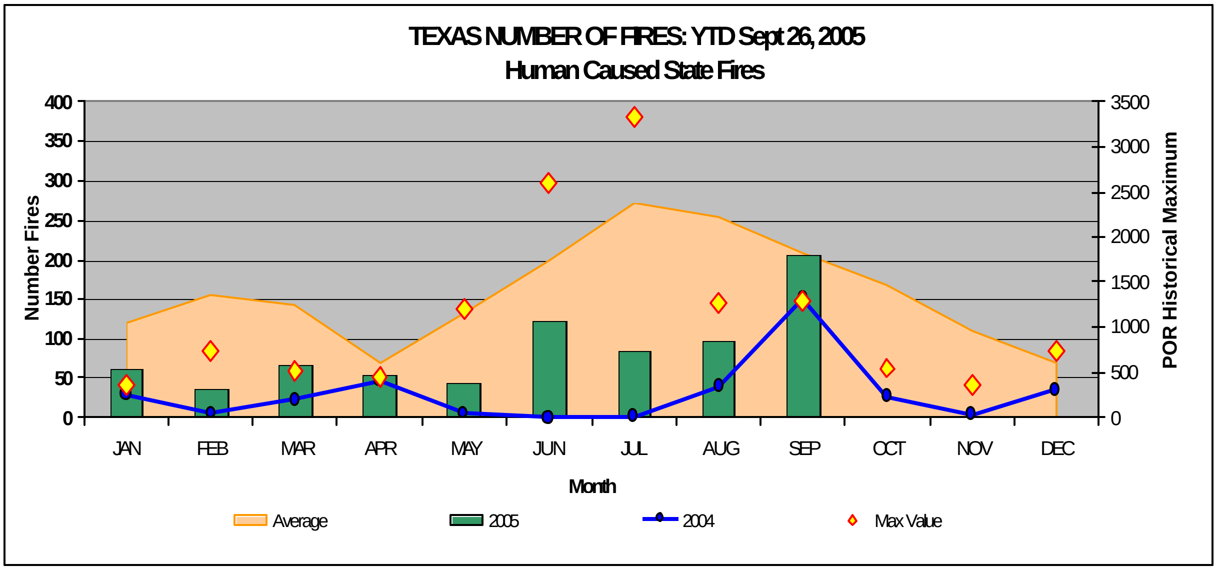
Fire Occurrence

Fires can occur year round in the damage affected area. Fire season can be generally described as the time of the year when fires occur and do significant damage. This is also generally year round in the affected area however there is a decline in fire activity in April, May and June. Fire starts in the area are mainly human caused. A large portion of human caused starts are debris burning and incendiary. On all the charts below, focus on the pink filled area which represents the 19 year historical number of fires. The left axis represents the number of fires, the secondary "Y" axis (on the right), shows the historic maximum number of fires. The bars illustrate the number of fires by month for 2005. It is very important to note that the fires reported on the state graphs represent only those fires reported by the state forest agencies and do not represent the total number of fires which likely occurred. The state fires are roughly 10% of the fire activity which likely occurred.



These two graphs show the number of fires for state/private and federal lands in Louisiana. Notice the state fires for Louisiana show a decline in activity for May and June. Also, there is a general decline in December, while the rest of the year has about 150 fires per month. The activity on federal lands illustrates a short decline in activity for November and December, followed by a sharp increase in activity January through March.





The Texas fire data shows a slight difference than what occurs in Louisiana. Notice on the state fires in Texas there is a decrease in fire occurrence from August to December. This is followed by an increase in fire activity in January. The peak of fire activity occurs in June, July and August.

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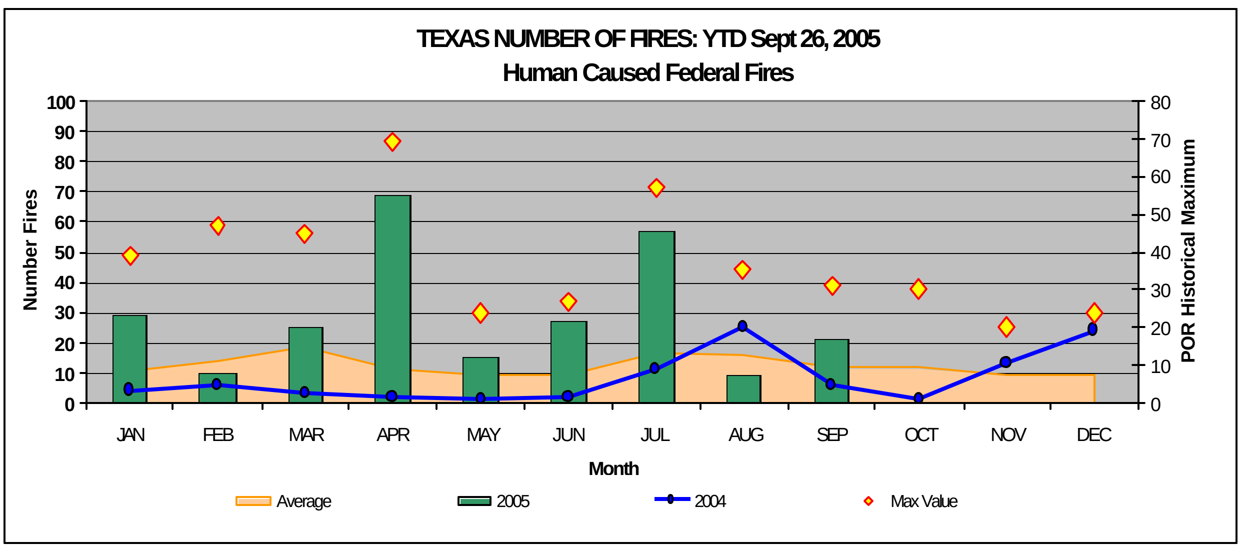
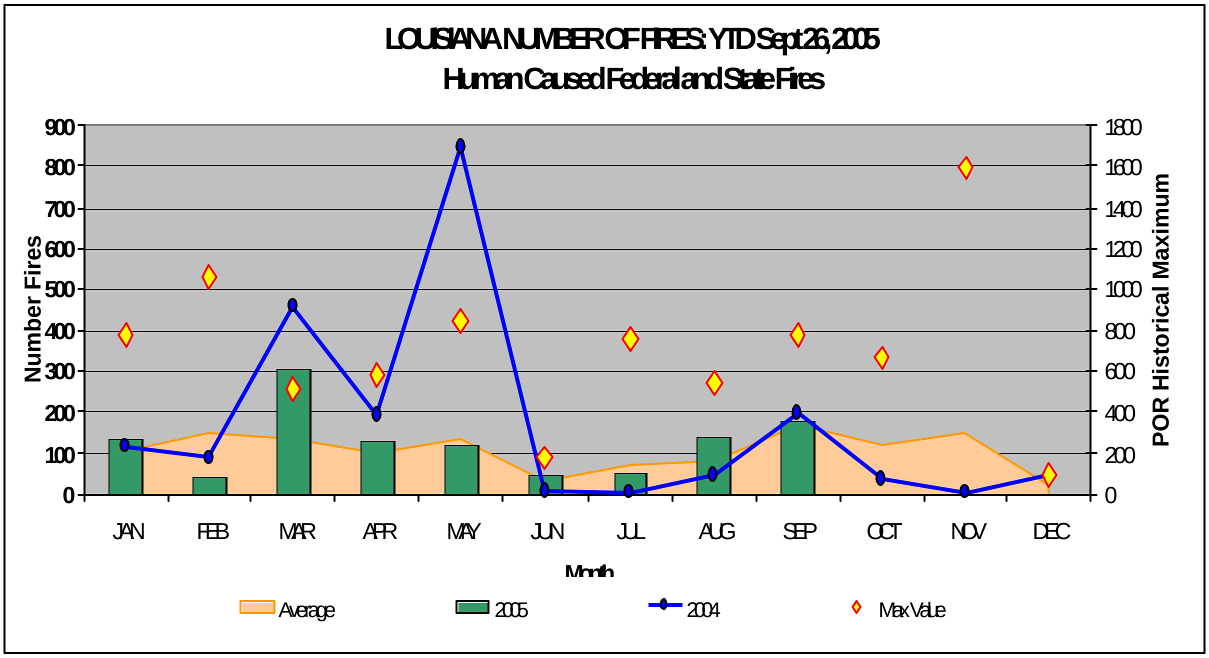
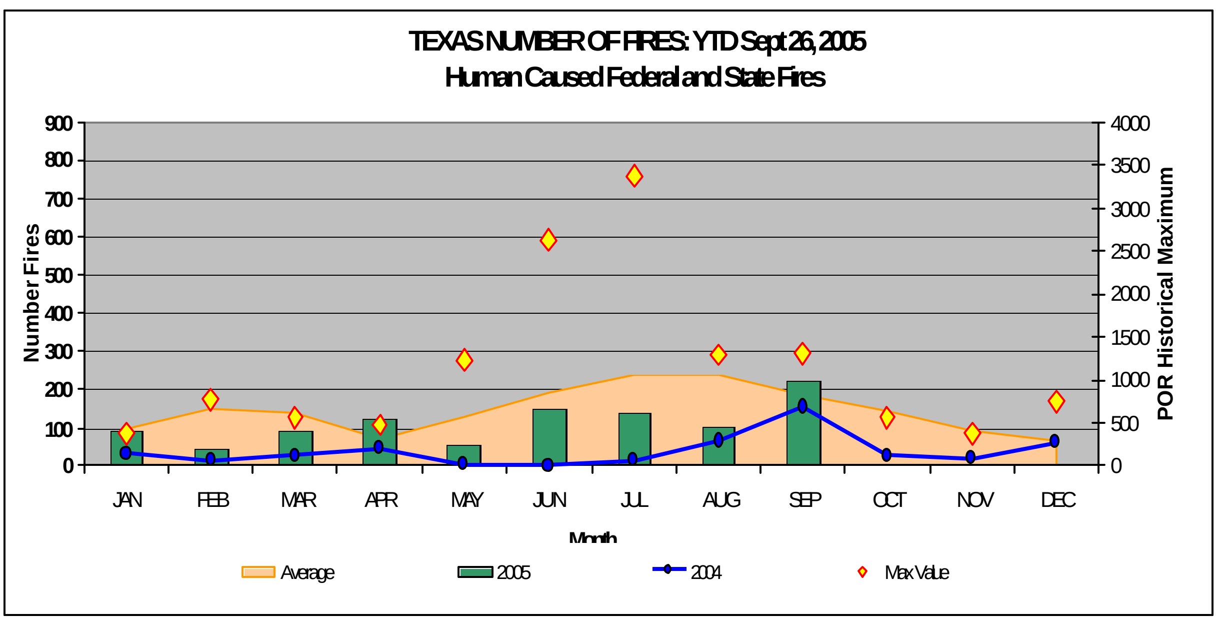
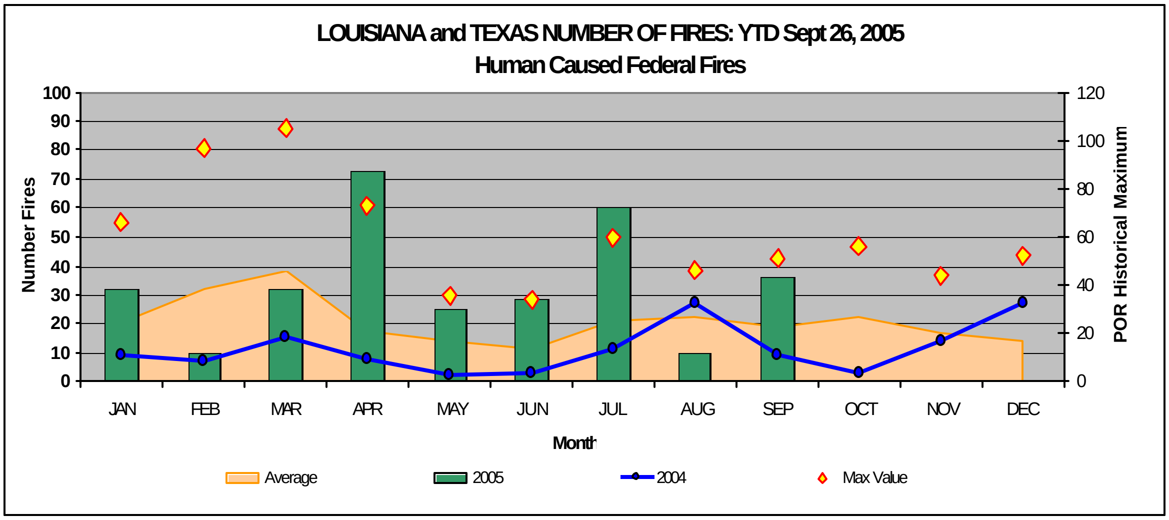
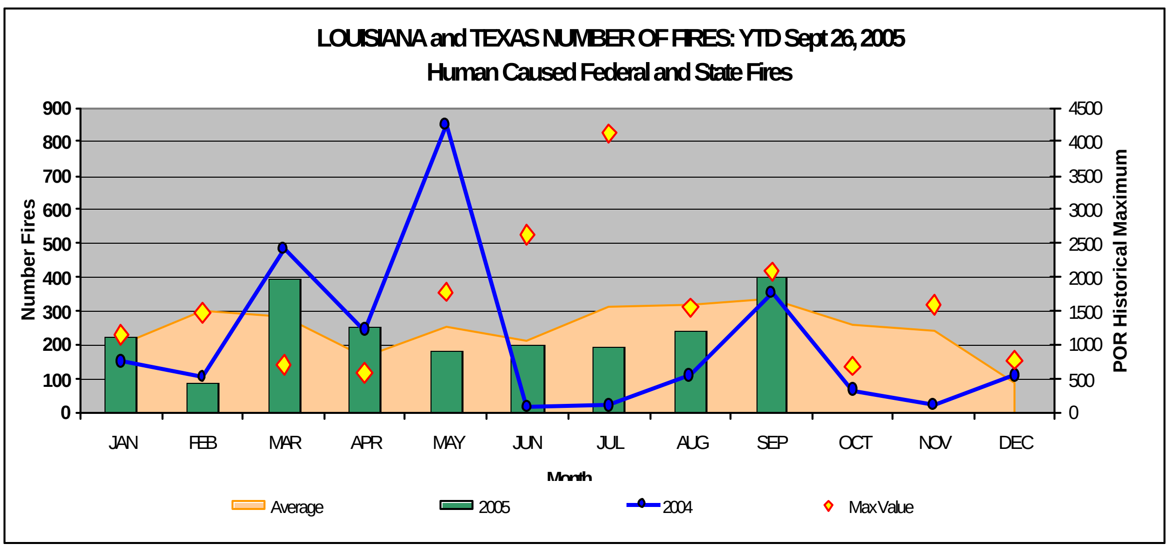



LOUISIANA NUMBER OF FIRES: YTD Sept 26, 2005
Human Caused Federal and State Fires
Number Fires
POR Historical Maximum
0
100
200
300
400
500
600
700
800
900
0
200
400
600
800
1000
1200
1400
1600
1800
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
Average
2005
2004
Max Value


TEXAS NUMBER OF FIRES: YTD Sept 26, 2005
Human Caused Federal and State Fires
Number Fires
POR Historical Maximum
0
100
200
300
400
500
600
700
800
900
0
500
1000
1500
2000
2500
3000
3500
4000
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
Average
2005
2004
Max Value



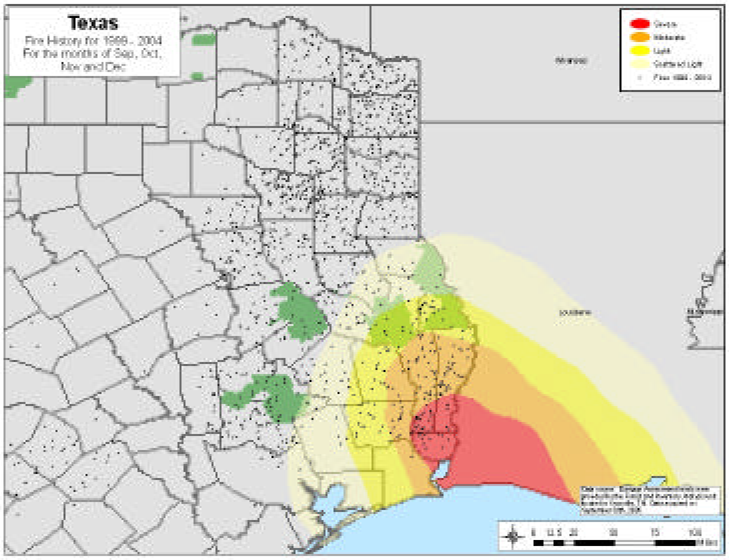
The combined federal and state fire occurrence for Louisiana and Texas illustrate a slight decline in November and December. This is followed by an increase in activity in January through April. Notice in September of 2005, the fire occurrence for these two states reached its historic maximum.



The data on fire activity for Texas and Louisiana bring to light the following important information. Human caused fires, particularly debris burning will likely be a large cause of fires in the very near future. This would indicate the importance of fire education and prevention efforts in the next couple of months along with increasing fire preparedness. Also, due to the large number of acres burned in late spring and early summer, preparedness, prevention and hazard fuel treatments will all become important prior to this time period.

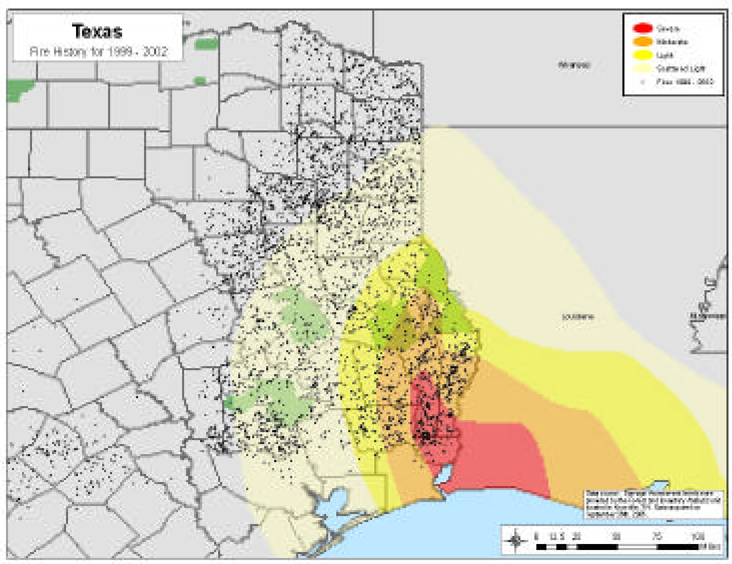
Fire restrictions and fire prevention should play a key role in fire management immediately. Fire prevention and fire restrictions efforts after Hurricane Katrina played a key role in reducing fire starts after the storm. Burning bans were placed in the severe and moderately affected counties. Also, prevention teams were established to make residents aware of the hazardous situation.

One of the major causes of fires after Hurricane Katrina was recharging of electric lines in the heavily damaged areas. This could also be a major cause of new starts after Hurricane Rita.



The image to the left depicts the number of fires in East Texas from 1999 to 2004 which occurred during the months of September through December. Damage levels are overlayed on the map. One can tell there is a considerable amount of fires historically occurring in the moderate to severe damage area.

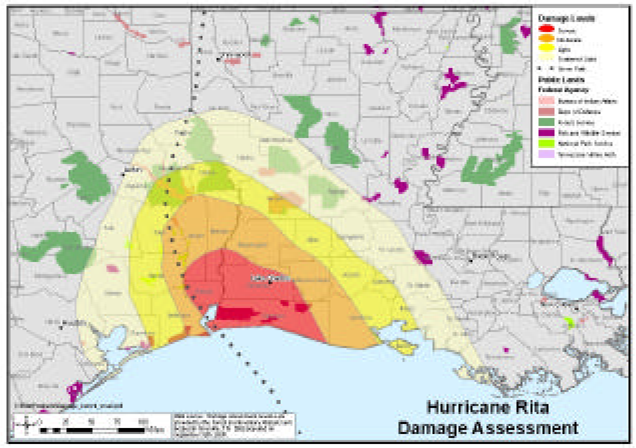
The map to the right illustrates number of fires in East Texas for all months which occurred from 1999 to 2004. One can see the large amount of fires which occur in the light, moderate and severe damage areas. This is a significant indication that fire prevention, fire preparedness, and fuel reduction activities will need to increase to effectively deal with the increased risk from fuel accumulation.



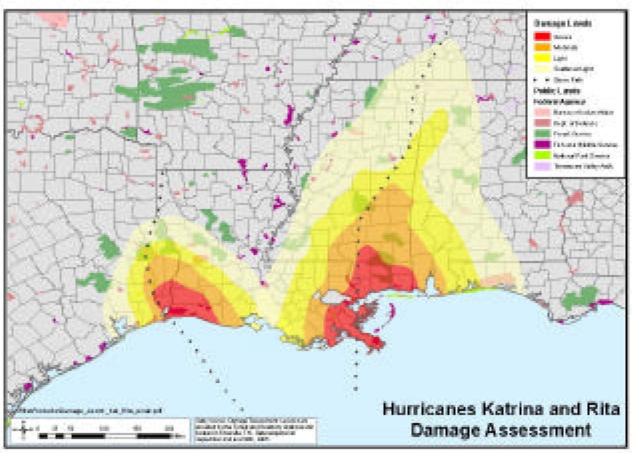
Wildland Urban Interface

The areas affected by the hurricane contain a vast amount of interface areas. Refer to the maps of WUI areas in the Appendix. This will provide a great challenge to wildland fire managers. Fire activity is normally higher in these areas due to debris burning. Fuel reduction and preparedness activities will need to be greatly enhanced to protect the communities at risk. Communities should develop a community protection plan to determine short and long term strategies.

Post-Hurricane Fuel Conditions



Determination of existing fuel conditions was done on a very general scale due to the time constraints. Damage levels were determined based on windspeed maps and rainfall patterns following landfall of Hurricane Katrina. These windspeed maps and rainfall patterns were compared with visual observations on the ground, looking at current damage. Observation included comparing these same windspeed/rainfall patterns with damage found on past hurricanes. Based on these past and current observations, four damage categories were determined. The adjective ratings for these four categories are: scattered light, light, moderate and severe. Damage level maps illustrating these categories are located in Appendix A.



Scattered light damage level is characterized by tropical storm forced winds (39 to 74 mph) and moderately heavy rain. The light damage level is described as low Category One Hurricane winds (generally less than 85 mph) and slightly heavier rains found in the scattered light damage level. The moderate damage level is determined by winds above 85 mph up to 111 mph (includes a high Category One and all wind speeds of a Category 2). Heavy rains are found in these areas. The severe damage area is characterized by Category 4 and 5 hurricane winds and very large rainfall amounts.

Fire Behavior Prediction System (FBPS) fuel model maps derived from the Southern Area Fire Risk Assessment were evaluated to determine which fuel models were present within each damage category. Based on past and current observations it can be determined the approximate amount of damage by fuel model, within each damage category.

The **scattered light damage level** is the most predominate across the effected area. Fuel loading in the damage level is the least impacted. Damage can be described as small limbs on the ground, the occasional tree blown over, and generally the same impact that would be associated with thunderstorm activity. No significant change to the fuel loading present prior to the hurricane. Fire behavior and potential will be the same as pre - hurricane levels. Fuel bed depth, particularly in hardwood and pine stands will increase slightly. The canopy is still in place.

A **light damage level** can be generally characterized by the same loading for each fuel model in the FBPS. However, there will likely be some additional fuel loading in the 1hr, 10hr, and 100hr fuel classes. Damage could be described as mainly small to large size tree limbs, downed trees, and an increase in litter on the ground. Fuel bed depth will increase moderately in timber stands. The canopy is slightly broken. Fire behavior and potential will increase in the short term in these areas. Expect slightly higher flame lengths and fire line intensities in the next few weeks as smaller diameter fuel classes dry out.

The **moderate damage level** has significant changes to the fuel models represented. In areas where a timber model is present (fuel model 8 and fuel model 9) expect more of a fuel model 11 (light slash) or fuel model 12 (moderate slash) to be represented after the storm. This area will see a wide diversity of fire behavior characteristics. Damage can be described as numerous small, medium and large diameter limbs are on the ground. A significant amount of trees are on the ground and tops broken out. The canopy of the forest is fragmented. The fuel bed depth for each fuel model has increased dramatically. Fuels are arranged more horizontally than vertically. The more open canopy will allow for an increase in solar radiation to reach the surface fuels, as well as, exposure to more winds. These effects will tend to exacerbate fire behavior beyond what would be accounted for by just adding more fuel. The resistance to control will also increase. The heavy fuel loading will make suppression more difficult. Control lines will need to be wider to have the same effect prior to the storms. Line construction rates will be slower and in some areas direct control lines will not be possible due to heavy loadings of larger material. Multiple kinds and types of resources will be needed for fire suppression. Aerial resources, combined with dozers and engines will be needed. Commitment of resources will be longer for each fire start due to longer mop up times, caused by the increase in heavy fuels on the ground.

The area of wide spread destruction of the forest stand itself is described as the **severe damage level**. In this area, around 25% to 40% of timber has been laid on the ground by the storms or all the tops have been broken. In areas where the pre-hurricane fuel model present was a FBPS fuel model 8 or 9, expect a fuel model 12 or 13. There is very little live fuel left in the fuel bed in the short term. A tremendous change in the fuel bed structure has taken place. 1hr, 10hr, 100hr, and 1000hr fuel loadings have all increased dramatically, especially the 1000hr. The forests could be considered “jack-strawed.” Prior to the storms, no fuel models 11, 12, and 13 existed in Alabama, Mississippi or Louisiana. Now these models are present in a large scale. The completely open canopy will drastically increase the amount of solar radiation to the fuel bed. This will cause dead fuels to rapidly dry out. This will also cause an increase in the mid flame wind speeds. The increase in available fuel will also increase the source for spotting and therefore increase the spotting potential. Smaller dozers (450’s) will be ineffective due to the increase in large diameters fuels on the ground. Large dozers (650’s) combined with engines and aerial resources will be needed to suppress fires.

Another critical issue that has impacted mainly the area closest to the coast is salt damage to vegetation. The picture to the right is salt damage from Hurricane Katrina. Notice how both the understory and overstory appear scorched. However, the dead needles remain on the tree. This could cause potential problems in the near future. It is likely these dead needles will drop to the ground and provide enough fine fuel to carry a fire. In areas where the needles remain on the trees, torching or crowning could occur if there is fuel build up below the canopies of the trees. Areas which have a heavy combination of brush will most likely prove the most volatile. These fuel types will have a heavy dead component to the understory and allow fire to move rapidly into the crowns. Prescribed burning in these areas will prove hazardous due to the volatile nature of the fuels. Prescribed burning will also likely produce higher concentrations of smoke and large particulate matter caused by the above normal amount of dead fuel.

Damage estimates (in acres) by Major Landownership

Total Lands affected (in acres) by Damage Levels	
Damage Levels	***Acres***
Severe	2,103,694
Moderate	3,388,342
Light	4,311,567
Scattered Light	7,610,129
Total Lands affected	***17,413,732***

Public Lands affected (in acres) by Damage Levels		State/Private Lands affected (in acres) by Damage Levels	
Damage Levels	***Acres***	***Damage Levels***	***Estimated Acres***
Severe	188,614	Severe	1,915,080
Moderate	80,049	Moderate	3,308,293
Light	689,890	Light	3,621,677
Scattered Light	948,043	Scattered Light	6,662,086
Total Public Lands affected	***1,906,596***	***Total St/Pvt Lands affected***	***15,507,136***

Damage estimates (in acres) by Forest and Damage Levels

Angelina NF	
Damage Levels	***Estimated Acres***
Severe	-
Moderate	2,888
Light	288,885
Scattered Light	101,457
Total Lands affected	***393,230***
Sabine NF	
Damage Levels	***Estimated Acres***
Severe	-
Moderate	-
Light	206,845
Scattered Light	247,622
Total Lands affected	***454,467***
Sam Houston NF	
Damage Levels	***Estimated Acres***
Severe	-
Moderate	-
Light	-
Scattered Light	32,570
Total Lands affected	***32,570***
Kisatchie NF	
Damage Levels	***Estimated Acres***
Severe	-
Moderate	-
Light	96,746
Scattered Light	391,644
Total Lands affected	***488,390***

Fire Behavior Implications:

Historical weather analysis was done using Fire Family Plus utilizing existing fire weather stations in Texas and Louisiana. Moderate weather and fuel conditions were determined to illustrate the difference in fire behavior potential by fuel type. This data was then input into Behave Plus to compare fire behavior outputs under "normal" fuel conditions to fire behavior outputs under current post-hurricane fuel conditions.

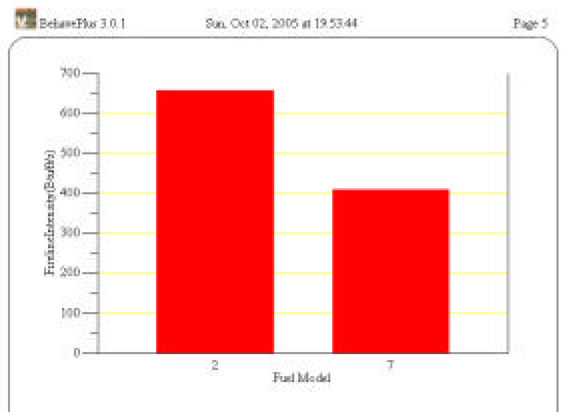
Coastal Marshes and Prairies

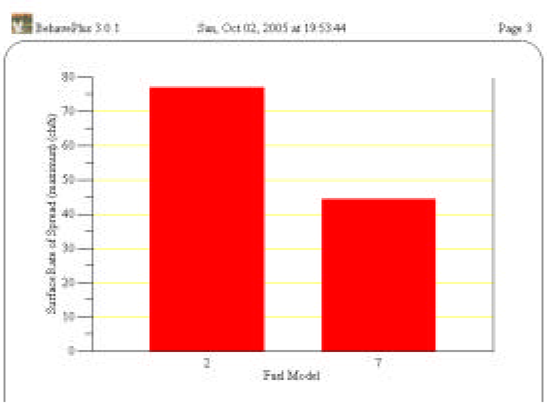
The major fire behavior implication from Hurricane Rita to the marshes and prairies will depend on the amount and duration of inundation from storm surge. Fresh water marsh grasses and prairie grasses cannot tolerate any salt water intrusion. In addition, many salt water marsh grasses cannot tolerate long periods of total submersion. In the short term, these areas of dead grass could result in more dead fine fuels that are receptive to fire spread or in the long-term could result in areas that become completely fire proof (convert to mud flats) if the grasses are unable to regenerate.

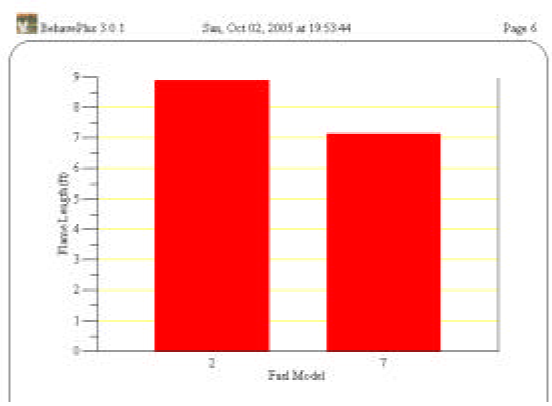
Pine Sandhill, Pine Forests

<u>Typical Fuel and Weather Conditions</u>

Pine sandhill and pine forests in eastern Texas and western Louisiana are typically modeled as a 2 or a 7 depending on the amount fine fuels (grass component) and condition of the shrub layer. The following Behave Plus outputs illustrate expected fire behavior under "normal" pre-hurricane fuel conditions:

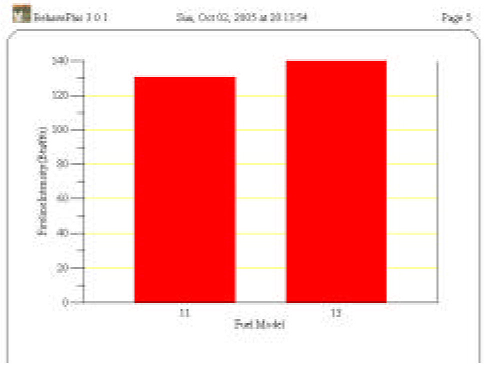


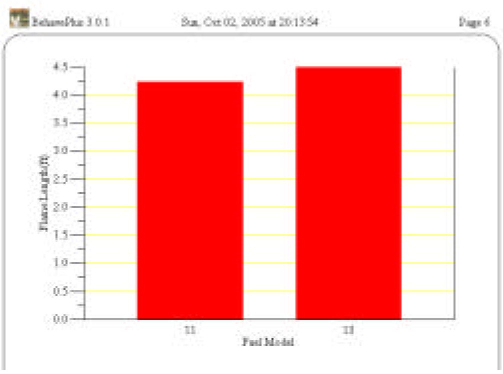


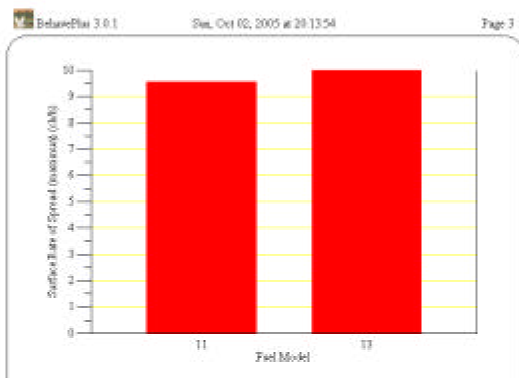


Post-Hurricane Fuel and Weather conditions

The major difference in post-hurricane fuel conditions is the increased loading of large diameter 100 and 1000 hour fuels. This change in fuel loading is best demonstrated with fuel models 11 (light slash) and 13 (heavy slash, high dead component). The following Behave Plus outputs illustrate the expected fire behavior with this increased fuel loading.







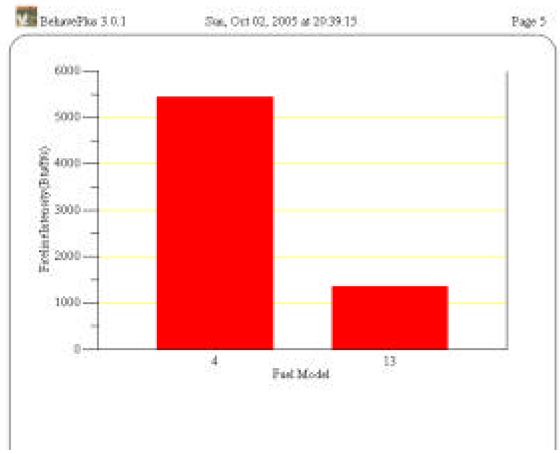
Pine Wetland Savannahs

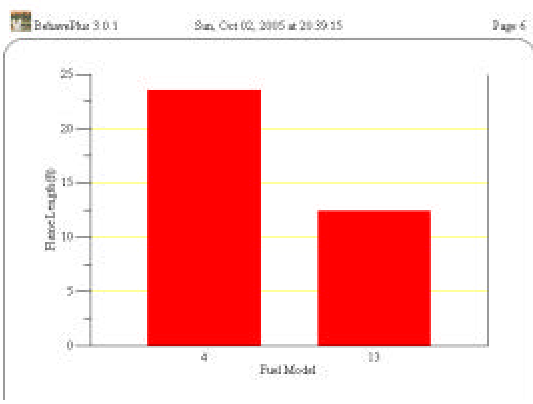
Normal Fuel and Weather Conditions

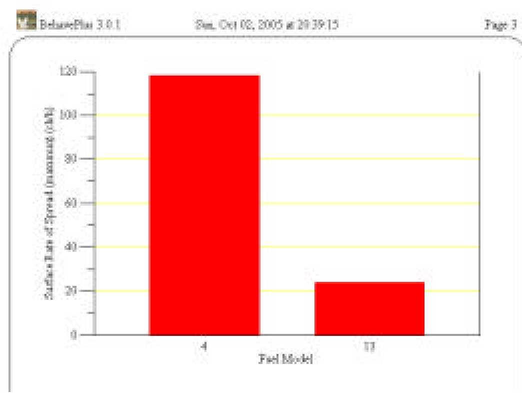
Pine wetland savannahs, under normal conditions, can be modeled as a fuel model 7. Under normal fuel and weather conditions it is often difficult to get this fuel type to burn because of high live fuel moistures. (see Fuel Model 7 outputs from Pine Forest and Pine Sandhill)

Post Hurricane Fuel Conditions

Increased fuel loading from needle drape and downed trees could convert this fuel type from a fuel model 7 to a fuel model 4 or 13 depending on the amount of time it takes for the pine needles to dry out. Increased solar radiation and decreased transpiration could cause these fuels to dry out to a greater extent than normal which would also contribute to increased fire behavior. The following Behave Plus outputs illustrate the expected fire behavior with this increased fuel loading.







Fire Behavior Implication Summary

The analyses determined that rate of fire spread will not change significantly however the added fuel loading will significantly change fire fighting tactics. Historically, flame lengths were within the limits for direct attack or a combination attack with small dozers (450's).

In the moderate to severe damage areas, fire line intensities under "normal" fuel moisture conditions will be too high for direct attack. This is due to the large amount of dead and down material available to burn. A combination and/or indirect attack will most likely be needed in the moderate to severely damages areas. Fires will generally become more fuel driven. This will increase the likelihood of extreme fire behavior under moderate fuel moisture conditions. Also, spotting will become more likely due to the amount of dead fuels on the ground. The increase in heavy dead fuels, down pines, and salt killed brush has created more source for spotting brands. The increase in fine fuels across the area will the receptive nature of the fuel bed. The larger diameter fuels will cause fires to burn more actively into the night.

Mop-up will be more difficult and the chances for holdover will increase. Longer commitment times for fire crews will be needed and this will decrease the capabilities of initial attack resources. Smoke production will also increase presenting additional challenges for aerial operations as well as health concerns down wind. Effect on remaining overstory will be more severe with increased scorch, torching and mortality.

Management Implications

The damage produced by Hurricane Rita has significant implications to fire management professionals. There are several management actions which apply across the board to all levels. The impact of Hurricane Rita will be in place for a long period of time. The Mississippi Forestry Commission, to this day, does not have access to some of the damage areas caused by Camille in 1979. Therefore, some base fire management day to day decision points may need to be re-evaluated due to the increase in fire potential. The National Fire Danger Rating System (NFDRS) is a trusted tool used by fire managers across the country and useful for determining staffing levels, dispatch levels, fire restrictions, adjective fire danger rating, and seasonal severity. Trigger points for these fire management decisions will need to be re-adjusted for changes in fuel type and to reflect new fire potential. Fire behavior will increase faster on lower “fire danger” days and will need to be staffed accordingly. Dispatch levels will need to reflect a higher fire potential. Therefore, more resources and different types of resources will need to be sent on lower risk days. Many land management agencies do not have breakpoints for these fire management decisions. A Fire Danger Operating Plan should be developed to adequately prepare for fire activity during the fire season.

The scattered light damage level will require very minimal, if any changes to current fire management activities. This area received the least amount of damage. The light damage level will require some additional preparedness activities. A slight increase in the number of initial attack resources on fires may be needed. Generally, no change in hazardous fuels activities. Regularly scheduled prescribe burns should reduce the increase in fuel accumulation.

The moderate damage level areas will require several changes to normal management activities. Due to increased fire potential in this area, fire prevention teams will be needed. Prevention work should focus on proper debris burning techniques, possible implementation of burning bans, and aggressive arson investigations. Preparedness activities will need to be greatly enhanced. Larger dozers and engines will be needed to deal with the increased fuel build up. Aerial resources will be needed to cool the fire and allow ground crews to get close. Aggressive detection will be needed to keep fires small. Hazardous fuels work will likely require mechanical treatments before prescribe fire can be utilized.

The severe damage area will require the most extensive change in management. Prevention teams will also need to be utilized in this area. Aggressive detection will also be needed. Larger dozers and engines will be needed in this area as well as aviation assets. Hazardous fuel reduction activities will require mechanical work before prescribed fire can be utilized.

Management Recommendations

Prevention: The previous hurricane and blowdown situations all implemented aggressive prevention programs. This is an important component of a wildfire mitigation plan. FIREWISE is an excellent tool that can be implemented quickly by prevention teams.

Debris burning is a leading cause of fires in the southeastern area. The highest period of incidence for these types of fires occurs in September, October, January, February and March. Prevention messages or limitations on these types of permits in areas of severe to moderately damaged areas are a high priority.

Fire restrictions may need to be re-evaluated. New restrictions may be temporarily put in place until fuel reduction goals are met. Also, the trigger points and criteria at which restrictions are put in place may need to be altered.

Land management agencies may need to take aggressive steps to reduce escape debris burning fires: such as designating gravel pits for debris disposal and burning that material. Fire prevention teams should take aggressive steps to educate the public on proper debris burning techniques.

Prevention teams can be used to provide overall coordination and provide expertise to local fire protection agencies.

Detection: Early detection is a critical step in keeping fires small and reducing loss of life, property and keeping suppression costs low. Criteria on when and where detection is utilized will need to be re-evaluated.

Preparedness: Upgrading to larger dozers will be necessary to work in areas where fuel treatments or salvage can not be accomplished. The smaller dozers and tractor plows generally in use will not be effective in the areas of heavier blowdown. This heavier equipment will be needed for up to three years before the loading drops and the boles soften to the point that the smaller dozers and tractor plows can be used. The smaller equipment will still be effective in areas not impacted by heavy blowdown. This equipment will be needed in the moderate to severe damage areas.

With the loss of a majority of the large airtankers to the federal fleet the need to supplement these resources will be critical. Helicopters and SEATs can be effective on fires when they are small. To be effectively utilized they must be activated early. States independently have the ability to contract additional larger airtankers that are not under federal contract. There would be limitations on their use on federal lands. The time of year when the largest number of fires and acres burned occur is outside the normal western fire season. Every effort should be made to provide at least one contracted heavy airtanker to the area affected.

Salvage Logging and utilization (as a form of fuel; treatment): Historically based on at least two of the case studies salvage logging has been only marginally effective. Still it remains a tool that can not be over looked. It will be important to accelerate the planning timeline to best recovery the economic value. After the 2004 hurricane season, a general estimate from the Alabama Forestry Commission and the Florida Division of Forestry is that 20% to 30% of the timber was successfully salvaged.

Training and equipment for state and local fire protection agencies will be needed and is recommended. Simply put some to of the equipment currently is service will not be up to challenge in the short run for dealing with the resistance to control that is now present. Training of local fire fighters will be necessary for them to understand the implications of fire behavior in these heavily modified fuels. Modifications in strategy and tactics will be required in order to increase the success of attack and increase the margins for safety. Volunteer Fire Departments respond to the vast majority of fires in this area. Increasing the capabilities of these departments should be critical. This should come in the form of increased training, equipment, and personal protective equipment.

Planning for community protection: Significant changes have taken place in and around communities. Many plans will need to be changed to reflect the changing fuel conditions. Those who have not yet completed plans should do so given the current conditions. Money is indicated to allow for the planning and for the implementation of some critical projects.

Locally disposal sites can be developed where small land owners and individuals can bring debris for burning or other chipping. This may reduce the potential for land owners wanting to burn by giving them a safer alternative. These locations can be advertised as part of the prevention messages.

Fuel treatments: There is a full range of options available and each has its time and place. These range from prescribed burning, piling, wind rowing, chipping, crushing and mulching depending on the situation. These treatments might be used in protecting communities or single structures. They might be used to break up large areas of continuous fuels by constructing fuel breaks. Or they might be used in a patchwork pattern based on Finny's models to reduce fire spread rates and intensity. The areas for treatment will need to be prioritized as time and money will be a limiting factor. This prioritization process is best left to the local states and forests to accomplish based on current community protection plans.

Fuel treatments need to focus on communities at risk located in or near areas of heavy and moderately damaged stands as a first priority. The locations of treatments should be placed on the edge where the most predominate winds come from during periods of high fire danger, windward side to be most effective. This will require a local analysis. Salvage operations, where possible, should be the first choice as a treatment alternative to reduce overall costs. It is estimated the savage effort will be successful on a large percentage of National Forest land. However, some mechanical fuel reduction work will be needed, as well as prescribe burning.

A second priority will be to treat areas of continuous fuel where spatially placed fuel treatment blocks (and salvage operations) can be used to slow the spread and reduce the intensity of fires. As a rough estimate based on Finny's work (Leuschen 2000) 15 percent of the area will need treatment.

Due to time constraints, an accurate total forested area needing treatment could not be determined. An estimate was based on the following assumptions:

- Only the light, moderate, and severe damage level areas needed treatment
- Based on this new total of acres within each damage category –
    - 20% of the severe damage level will need to be treated
    - 10 percent of the moderate damage level will need to be treated
    - 5 percent of the light damage level will need to be treated

Issues needing consideration

Fire weather forecasts indicate there this continued potential for additional storms to impact the United States. Should this happen modifications to the plan would be in order.

Salvage is expected to significantly reduce fuel reduction costs, particularly on National Forest lands. If this turns out not to be the case, further evaluation of fuel reduction priorities will be needed.

Smoke production and management will become more of an issue for prescribed fires and wildfires for the next decade or so. A stepped up campaign to inform the public will be needed.

The number of acres identified as needing treatment and the costs of those treatments are extraordinary. The team anticipates that the money will be a limiting factor in implementation. Should funding become available the sheer magnitude of the job will be difficult to accomplish. As a result additional local assessments will be needed in order to prioritize the acres for treatment, identify specific cost effective treatments and facilitate implementation. It is beyond the capability of this team to undertake this task due to the number of unknowns present.

Conclusions

- Hurricane Rita dramatically increased fuel loading and will have profound effects on fire behavior for many years. Areas hardest hit have seen increases as much as 15 fold in down and dead fuels.
- Based on the current fuel conditions and forecasted weather patterns, the damaged area will be in risk from wildland fire in the short term future. Generally, 10 to 14 days, post hurricane.
- The state or federal agencies are not currently prepared to take on the additional work that this change in fuels and resulting fire behavior will generate.
- Additional initial attack support to the federal, state and local fire departments will be needed in order to reduce the potential for large destructive fires.
- Fuel treatments by various methods will need to be implemented as soon as possible to begin mitigation before the beginning fire season.
- Prevention activities have proven effective in reducing human caused fire and needs to be aggressively implemented.
- Additional detailed state and local assessments will be required to develop site specific recommendations and set priorities.

Acknowledgements

The team would like to thank Burl Carraway (Texas Forest Service) for the timber damage assessment, Tom Spencer (Texas Forest Service) for valuable information on current fuel conditions, James Flue (National Forests and Grasslands in TX) for photos of the damaged area, Kirk Casanova (Louisiana Office of Forestry), for providing valuable information on conditions across the state and input. Jon Wallace (Mississippi Forestry Commission) for input into the extensive damage along the coast, impact on fuel conditions and pictures. Kevin Scasny and Denver Ingram (Southern Area Coordination Center) for providing some graphics and input into future weather conditions. Dennis Jacobs (Southern Research Station) for providing the initial damage assessment map.

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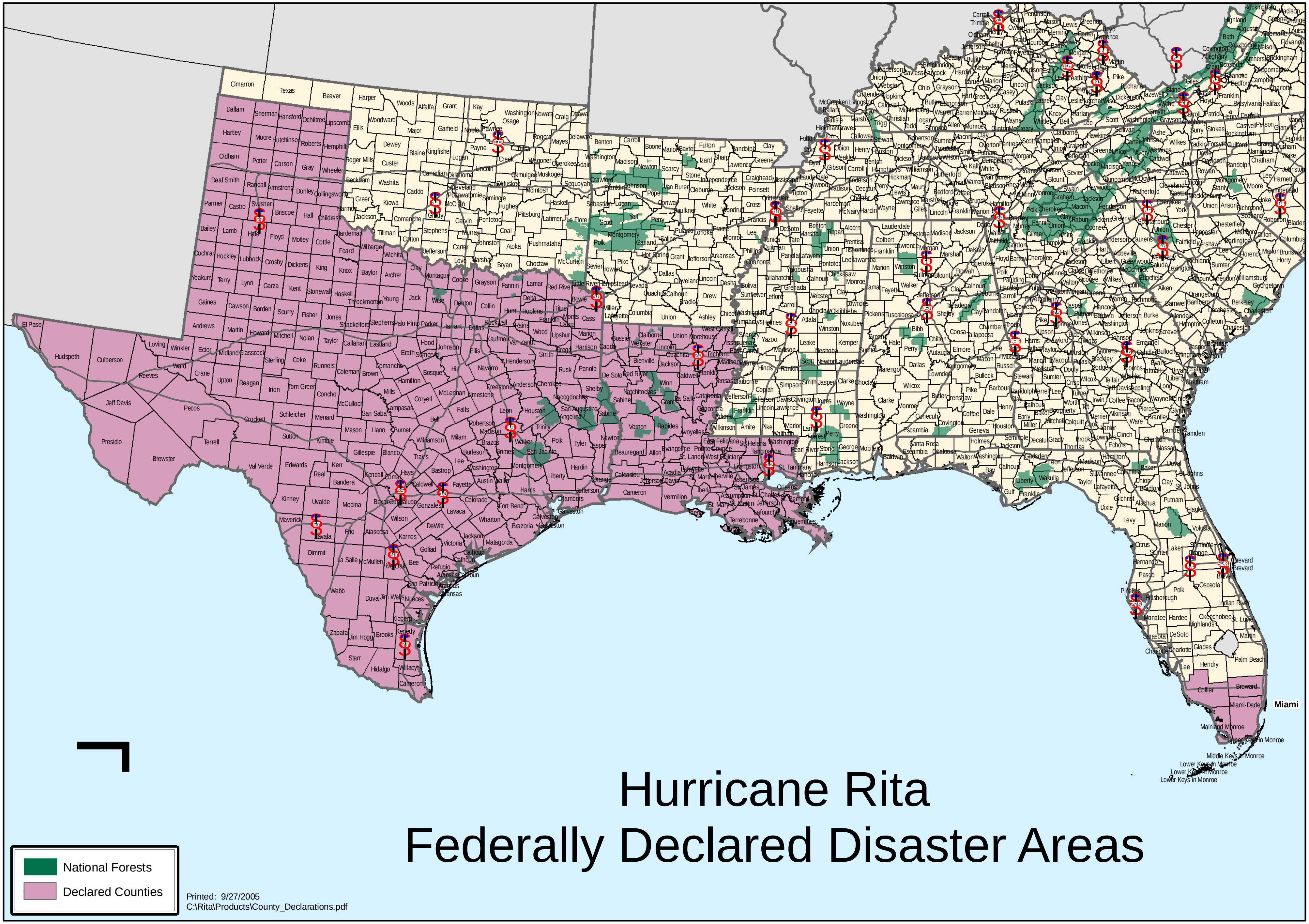
Leuschen, Tom; Wordell, Tom; Finney, Mark; Anderson, Doug; Aunan, Tim; Tine', Paul. 2000. Fuels Risk Assessment of Blowdown in Boundary Waters Canoe Area Wilderness and Adjacent Lands.
http://www.fs.fed.us/r9/forests/superior/storm_recovery/bwcara/bwcawra.html#_Toc474543973

Appendix



Hurricane Rita
Federally Declared Disaster Areas

Printed: 9/27/2005
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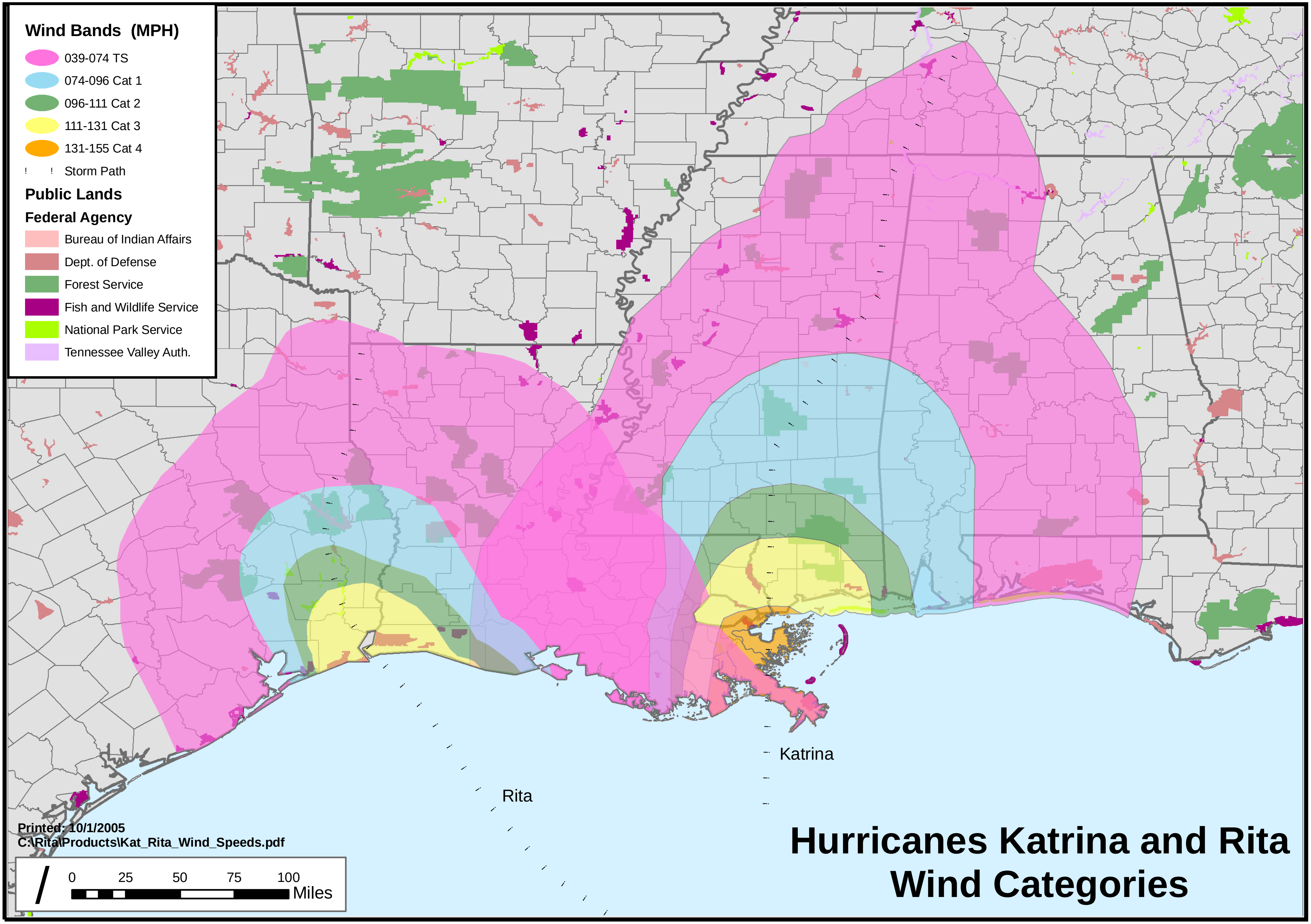
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039-074 TS
074-096 Cat 1
096-111 Cat 2
111-131 Cat 3
131-155 Cat 4
Storm Path
Public Lands
Federal Agency
Bureau of Indian Affairs
Dept. of Defense
Forest Service
Fish and Wildlife Service
National Park Service
Tennessee Valley Auth.
Katrina
Rita
Printed: 10/1/2005
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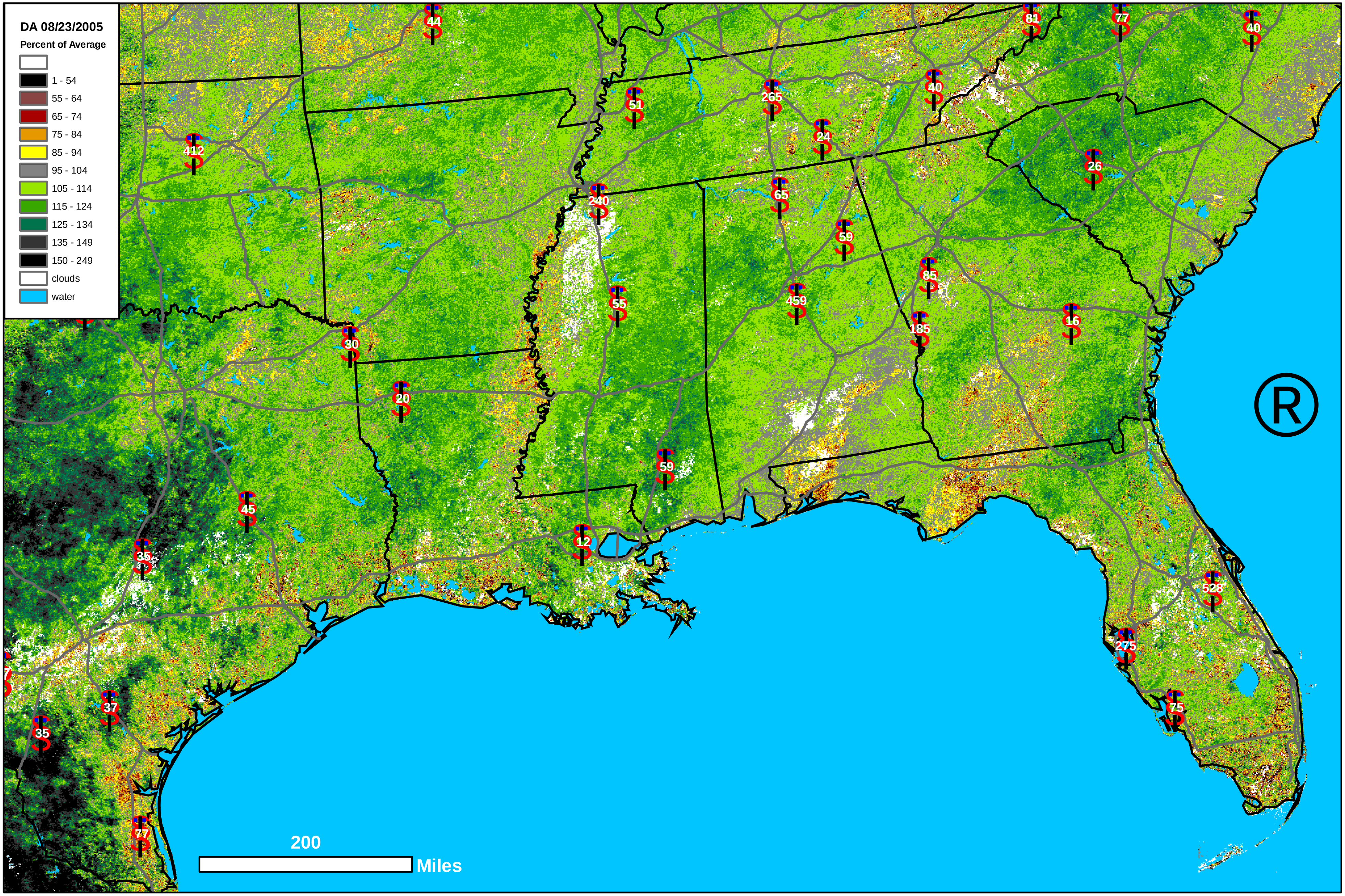
0 25 50 75 100
Miles
Hurricanes Katrina and Rita
Wind Categories

Departure from Average Vegetation Condition
August 23, 2005



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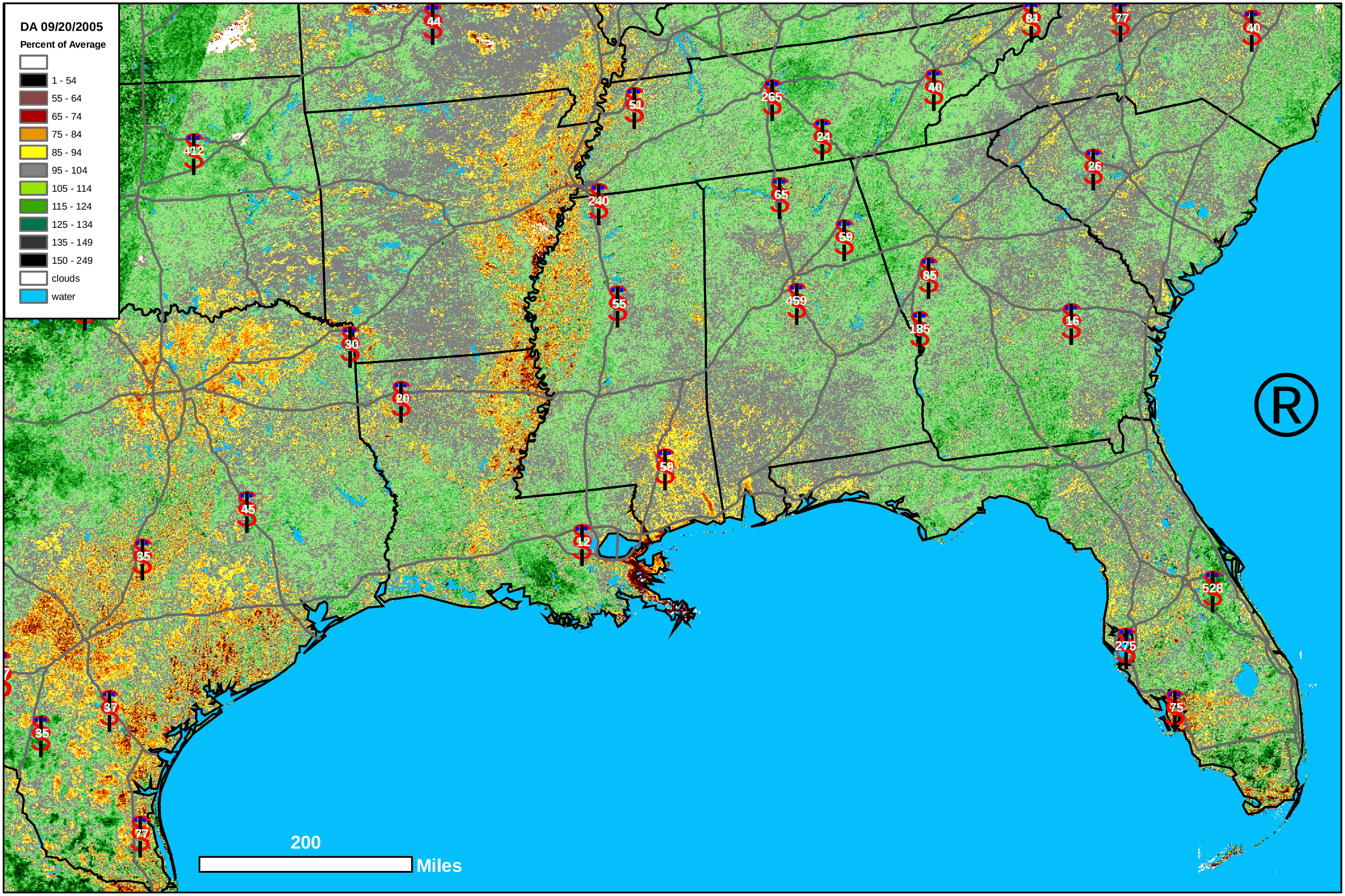
September 20, 2005



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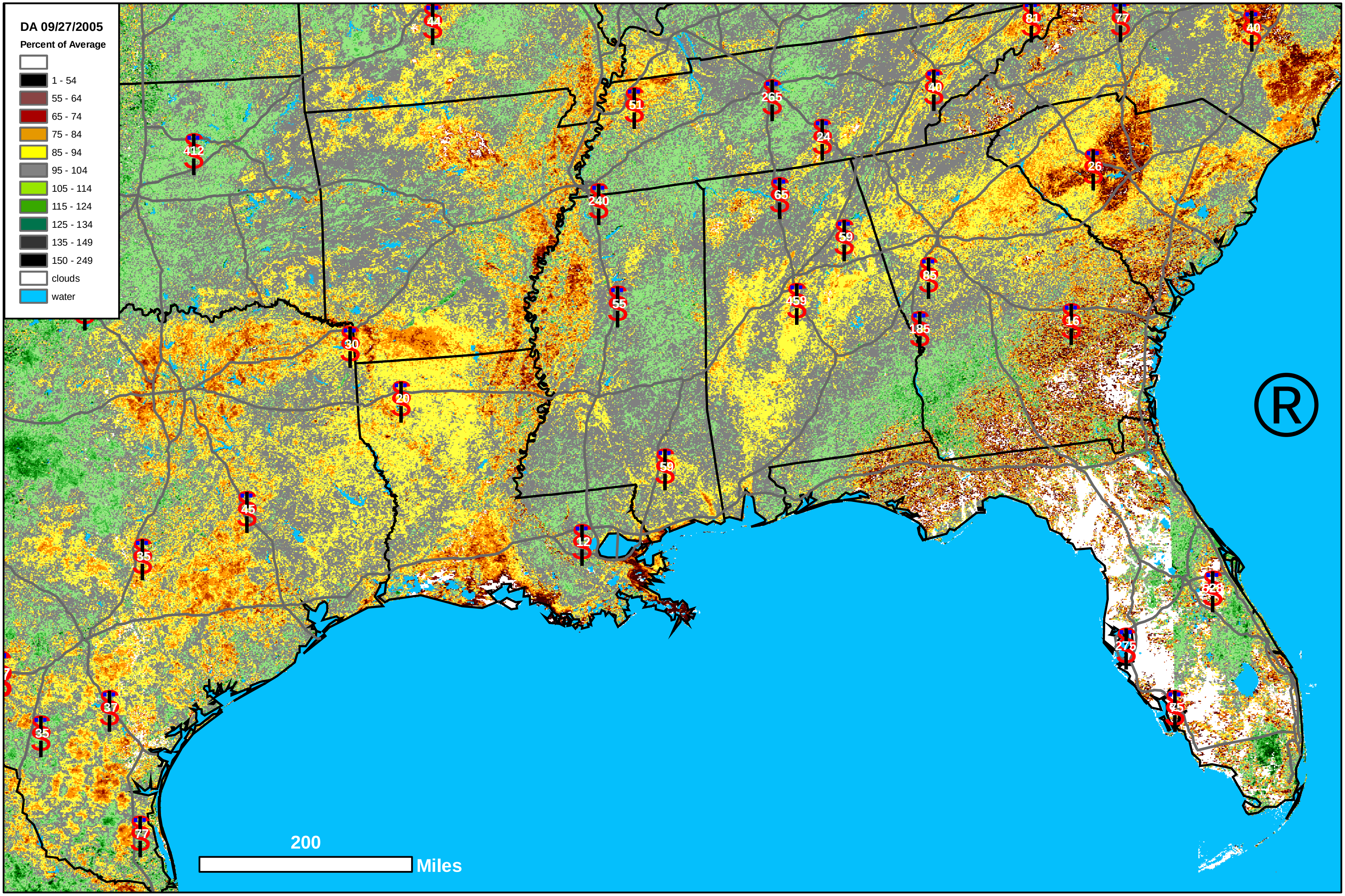
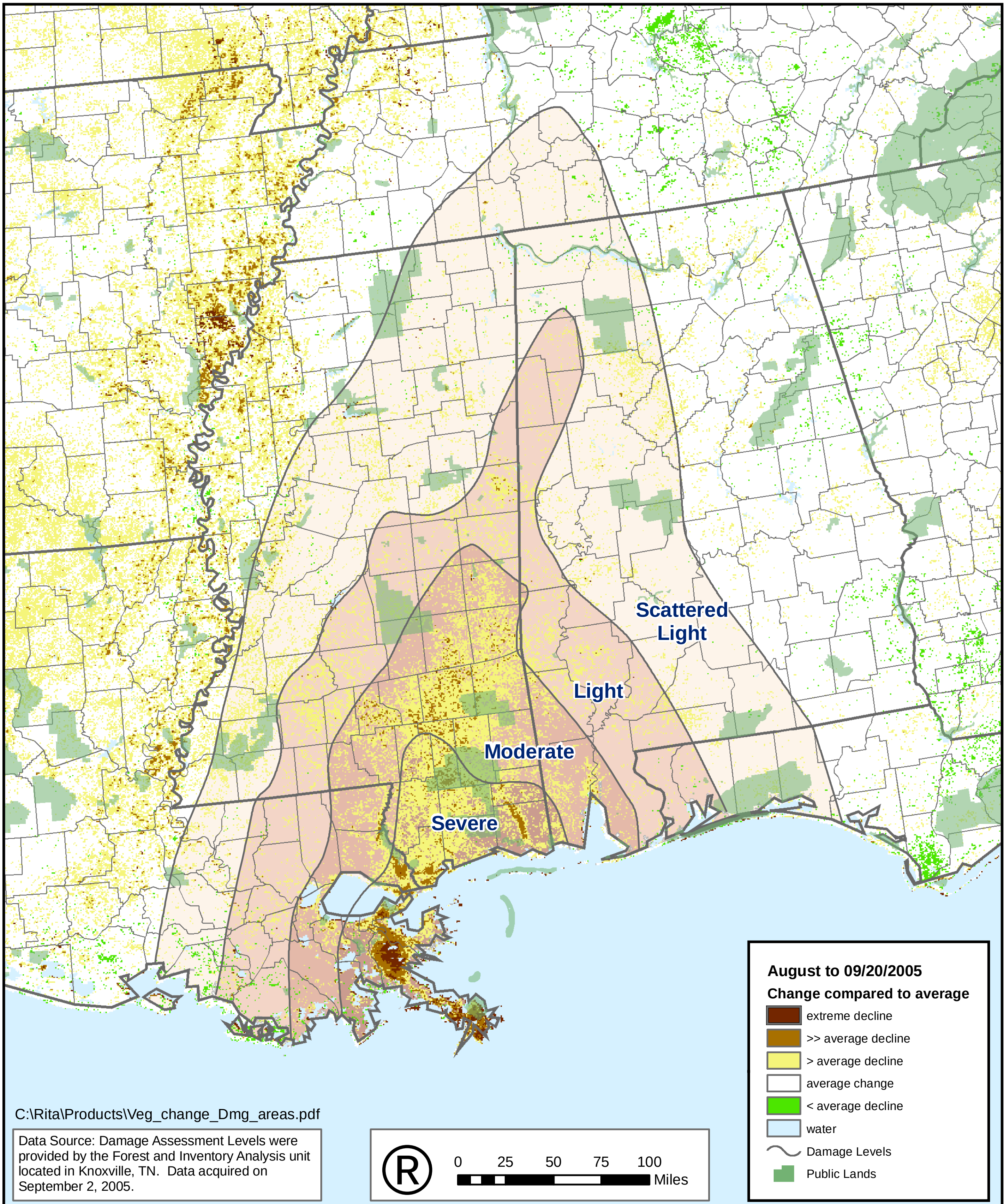
September 27, 2005



Change in Vegetation Condition
As Compared to Average Change
August to September 20, 2005



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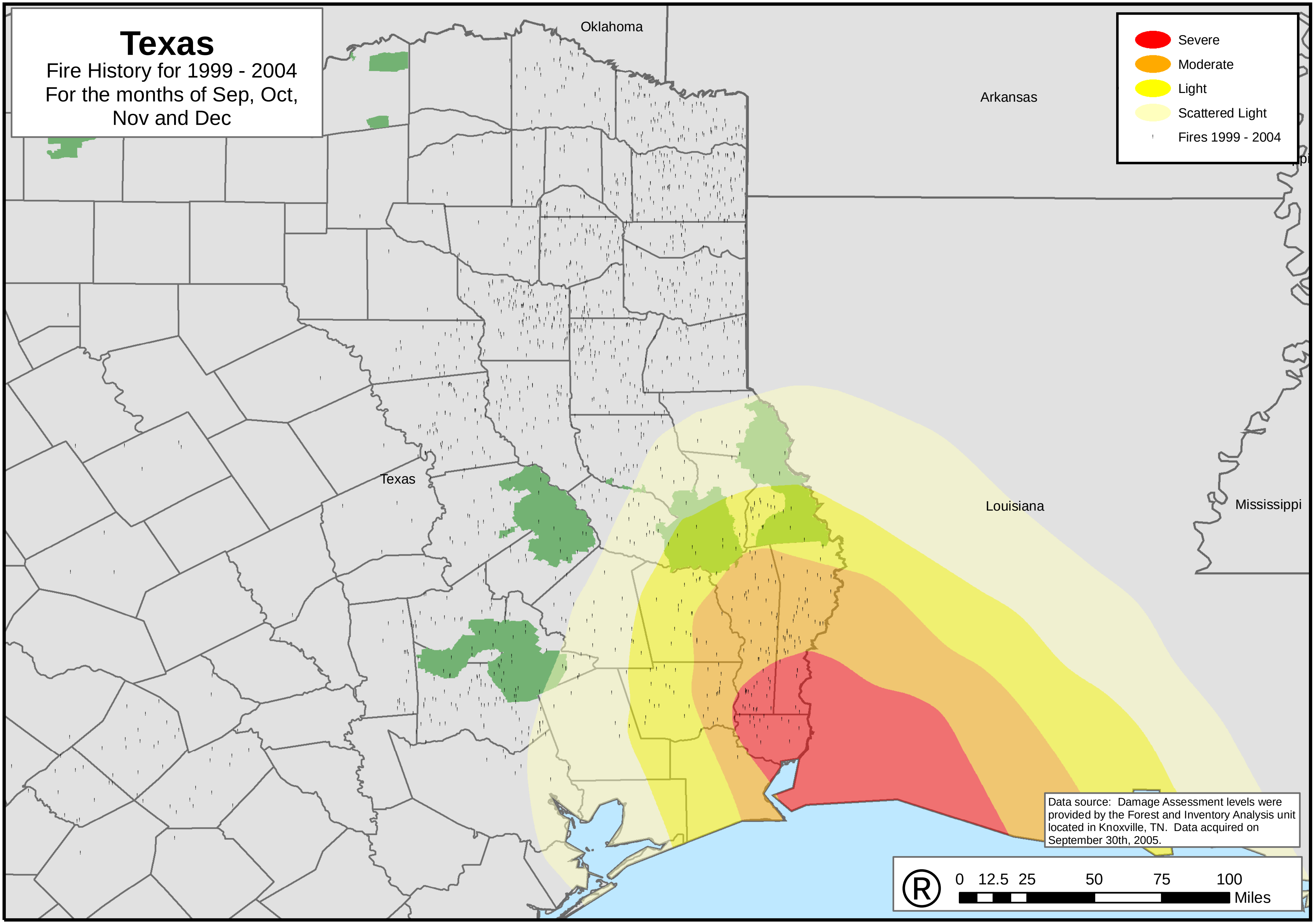
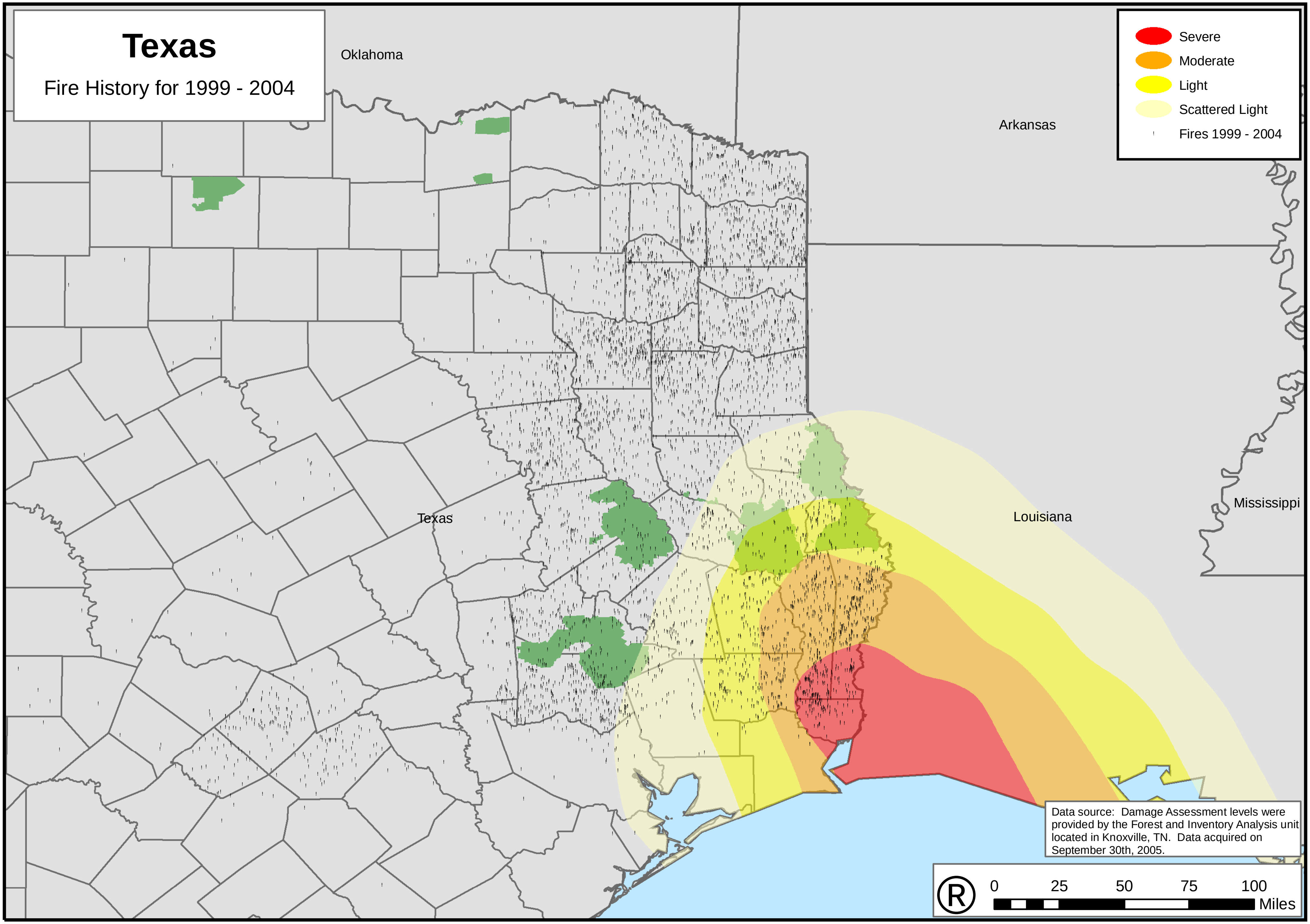
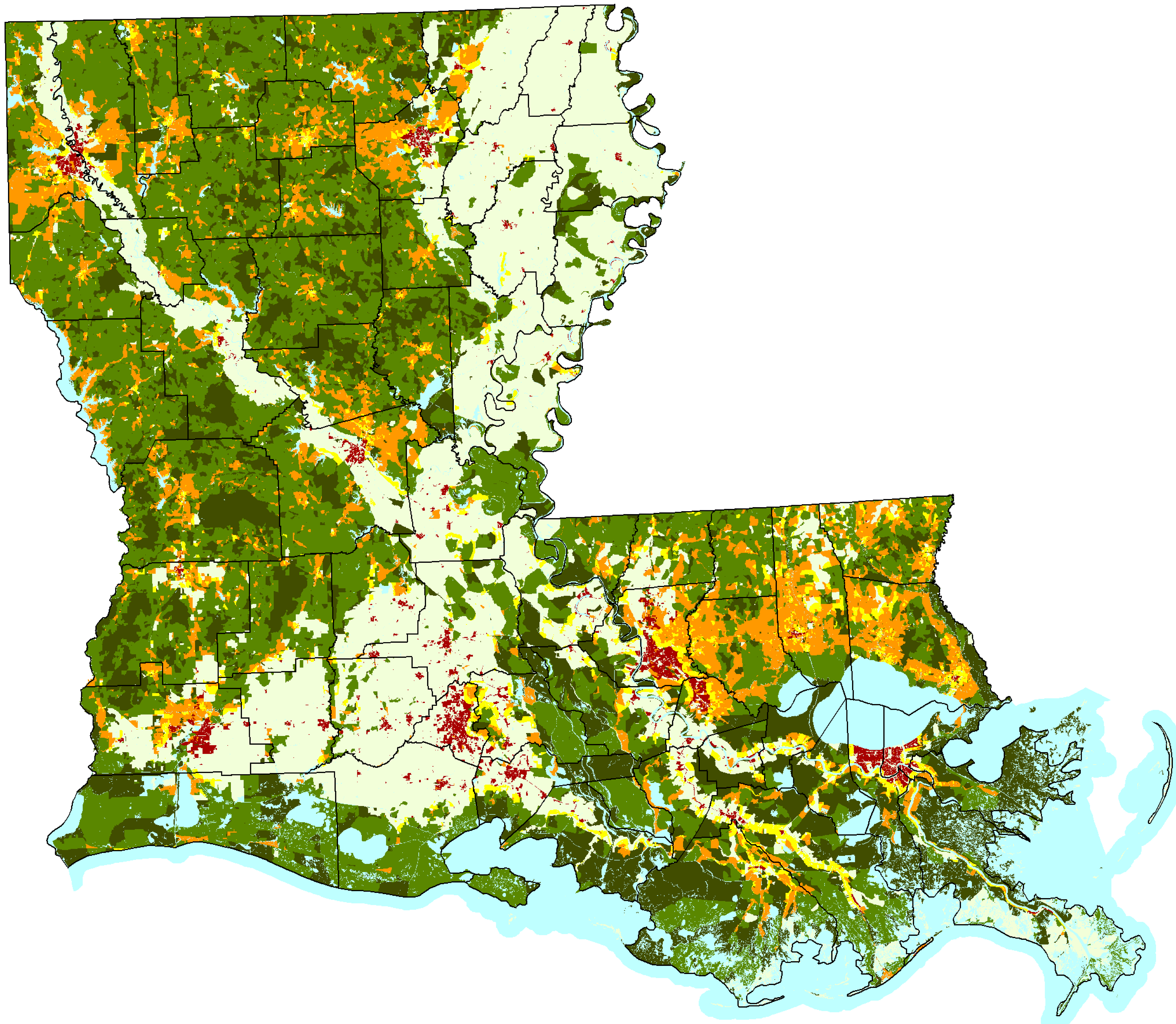

Texas
Fire History for 1999 - 2004
For the months of Sep, Oct, Nov and Dec
Oklahoma
Arkansas
Texas
Louisiana
Mississippi
Severe
Moderate
Light
Scattered Light
Fires 1999 - 2004
Data source: Damage Assessment levels were provided by the Forest and Inventory Analysis unit located in Knoxville, TN. Data acquired on September 30th, 2005.
0 12.5 25 50 75 100
Miles



Texas
Fire History for 1999 - 2004
Oklahoma
Arkansas
Texas
Louisiana
Mississippi
Severe
Moderate
Light
Scattered Light
Fires 1999 - 2004
Data source: Damage Assessment levels were provided by the Forest and Inventory Analysis unit located in Knoxville, TN. Data acquired on September 30th, 2005.
0
25
50
75
100
Miles

Louisiana

Wildland Urban Interface 2000



WUI

- Intermix
- Interface

Non-WUI

Vegetated

- Very Low Density Housing
- No Housing

Non-Vegetated or Agriculture

- Medium and High Density Housing
- Low and Very Low Density Housing

- County Boundaries
- Water

Map Version: January 2004

Kilometers: 0, 20, 40, 80, 120, 160

Miles: 0, 10, 20, 40, 60, 80

Research funded by the USDA Forest Service

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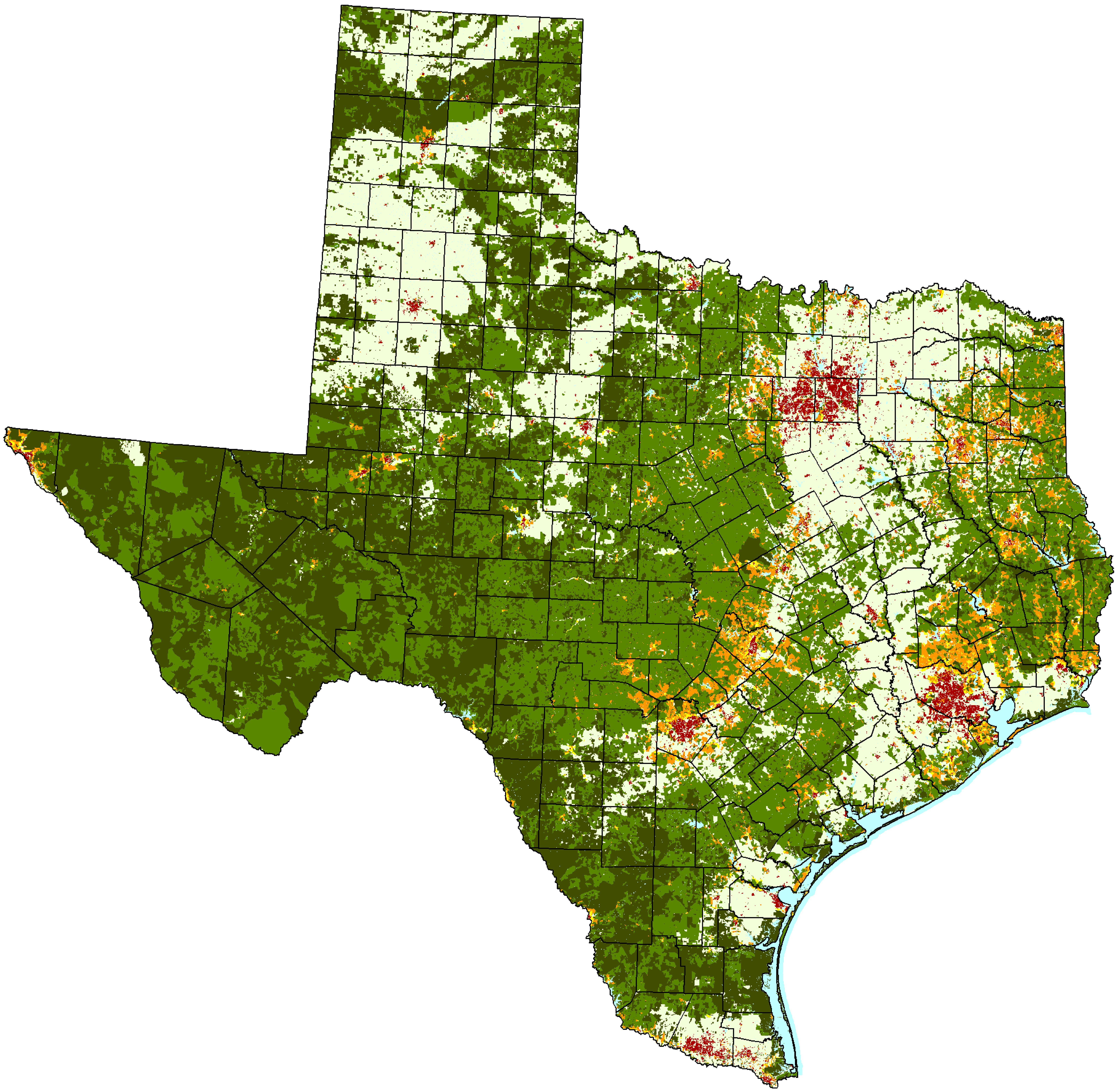
Sherry Holcomb, Jason McKeefry
Contact: Volker Radeloff
radeloff@facstaff.wisc.edu

- Intermix WUI is >50% vegetated and has at least low housing density
- Interface WUI is not vegetated, has at least low housing density, and is within 2.414 km of an area that is >75% vegetated and >5 sq. km in size
- Housing density is measured in units per sq. km. Density classes are very low (<6.17), low (6.17-49.21), medium (49.21-741.31), and high (>741.31)
- Vegetation includes forest, shrub, grassland, transitional or wetland but not agriculture (NLCD 1992/1993).
- Mapping units are 2000 US census blocks (US Census Bureau)
- Definition is based on the Federal Register (USDI/USDA 2001, vol. 66: 751)

Texas

Wildland Urban Interface 2000



WUI

- Intermix
- Interface

Non-WUI

Vegetated

- Very Low Density Housing
- No Housing

Non-Vegetated or Agriculture

- Medium and High Density Housing
- Low and Very Low Density Housing

- County Boundaries
- Water

Map Version: January 2004

Kilometers

0 40 80 160 240 320

0 20 40 80 120 160

Miles

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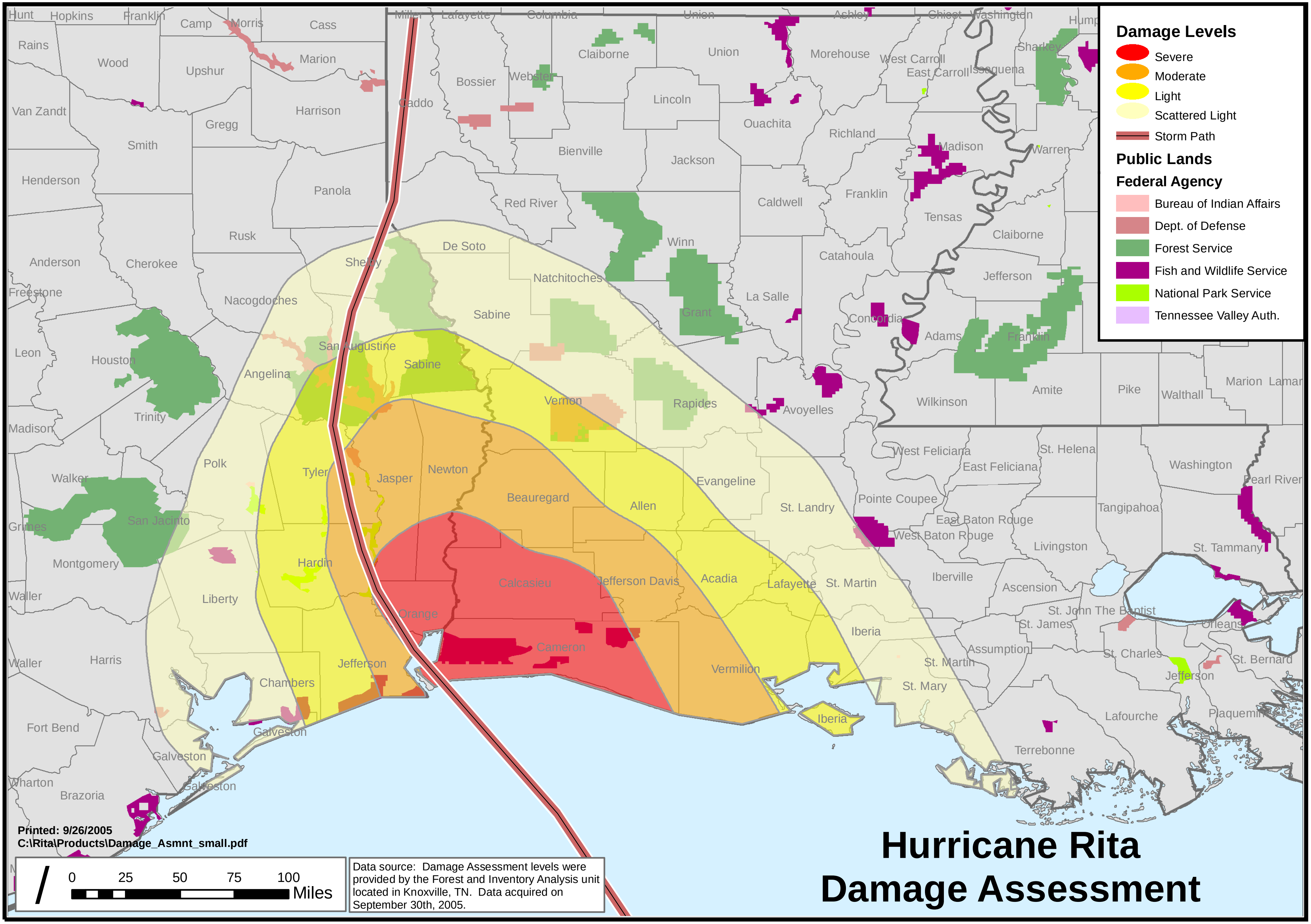
Hurricane Rita
Damage Assessment
Damage Levels
Severe
Moderate
Light
Scattered Light
Storm Path
Public Lands
Federal Agency
Bureau of Indian Affairs
Dept. of Defense
Forest Service
Fish and Wildlife Service
National Park Service
Tennessee Valley Auth.
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0 25 50 75 100
Miles
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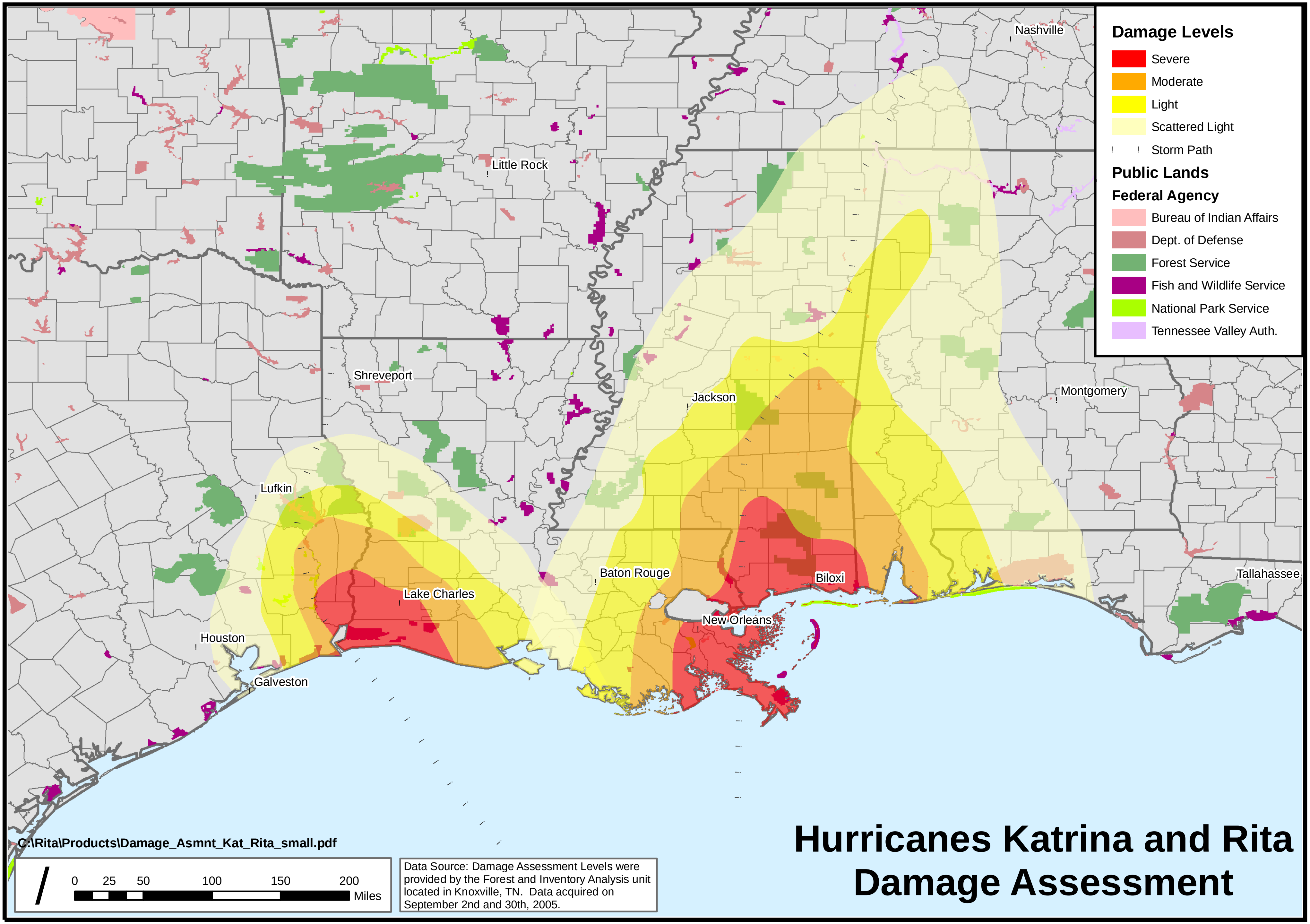
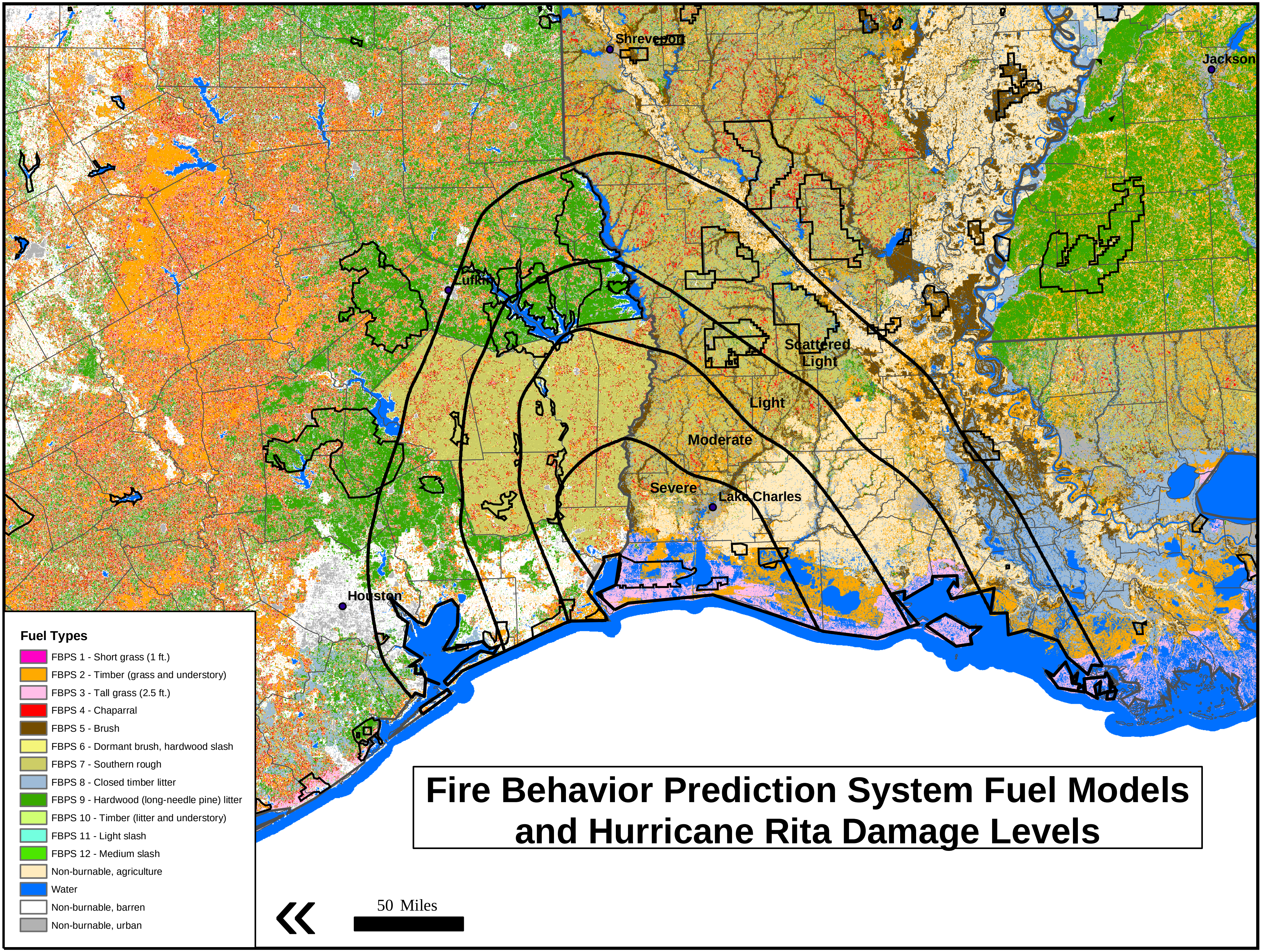
Calcasieu
Cameron
Jefferson Davis
Beauregard
Allen
Vernon
Newton
Jasper
Orange
Jefferson
Hardin
Tyler
Sabine
San Augustine
Acadia
Vermilion
Evangeline
Rapides
Natchitoches
De Soto
Shelby
Angelina
Polk
Liberty
Chambers
Galveston
Harris
Lafayette
St. Landry
St. Martin
Iberia
St. Mary



Damage Levels
Severe
Moderate
Light
Scattered Light
Storm Path
Public Lands
Federal Agency
Bureau of Indian Affairs
Dept. of Defense
Forest Service
Fish and Wildlife Service
National Park Service
Tennessee Valley Auth.
Nashville
Little Rock
Shreveport
Jackson
Montgomery
Lufkin
Baton Rouge
Biloxi
Tallahassee
Lake Charles
New Orleans
Houston
Galveston
C:\Rita\Products\Damage_Asmnt_Kat_Rita_small.pdf
0 25 50 100 150 200
Miles
Data Source: Damage Assessment Levels were provided by the Forest and Inventory Analysis unit located in Knoxville, TN. Data acquired on September 2nd and 30th, 2005.
Hurricanes Katrina and Rita
Damage Assessment


Shreveport
Jackson
Lufkin
Scattered
Light
Light
Moderate
Severe
Lake Charles
Houston
Fuel Types
FBPS 1 - Short grass (1 ft.)
FBPS 2 - Timber (grass and understory)
FBPS 3 - Tall grass (2.5 ft.)
FBPS 4 - Chaparral
FBPS 5 - Brush
FBPS 6 - Dormant brush, hardwood slash
FBPS 7 - Southern rough
FBPS 8 - Closed timber litter
FBPS 9 - Hardwood (long-needle pine) litter
FBPS 10 - Timber (litter and understory)
FBPS 11 - Light slash
FBPS 12 - Medium slash
Non-burnable, agriculture
Water
Non-burnable, barren
Non-burnable, urban
50 Miles
Fire Behavior Prediction System Fuel Models
and Hurricane Rita Damage Levels